SCIENTIFIC AMERICAN SUPPLEMENT. No. 1000

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Scientific American Supplement, Vol. XXXIX. No. 1000. NEW YORK, MARCH 2, 1895. Scientific American Supplement, $5 a year.
Scientific American, established 1845. Scientific American and Supplement, $7 a year.

THE NEW PRESIDENT OF THE FRENCH REPUBLIC.

M. CASIMIR-PERIER, who succeeded M. Carnot as President of France, resigned his office January 15, 1895. The Versailles Congress, which assembled January 17, was composed of all the Senators and Deputies, according to the Constitution of France. On the second ballot M. François Felix Faure, member of the Chamber of Deputies for Seine-Inferieure and Minister of Marine in the Cabinet of M. Dupuy, was elected President of the French Republic to succeed M. Casimir-Perier. The vote for M. Faure was 430, against 361 for M. Henri Brisson, the candidate of the Radicals and Socialists. The new President was born in Paris, January 31, 1841. In early life he was a shipping broker and ship owner at Havre and was for several years President of the Chamber of Commerce there. He distinguished himself in the Franco-Prussian war.

M. Faure entered the political arena in 1881, when he was elected to the Chamber of Deputies. He was soon appointed Under-Secretary of State for Commerce and Colonies. He held this post with a break of a little more than a year and a half until 1885, when he went out of office. He had by this time obtained great influence among the leaders of the Union Republican group, and his opinion on colonial questions was highly regarded. He was elected by the Republicans on October 4, 1888, from the Department of the Seine-Inferieure, receiving 80,559 out of 149,546 votes cast. On September 22, 1889, he was elected to the Chamber of Deputies. After the assassination of M. Carnot and the elevation of M. Casimir-Perier to the Presidency, M. Faure became the Minister of Marine, which position he held until the cabinet resigned, which precipitated the crisis which resulted in the resignation of the President. The election of M. Faure did not arouse much enthusiasm. M. Faure is an author as well as politician. A few years ago he published an important work on the comparative budgets of the different nations. He has been a Chevalier of the Legion of Honor since May 31, 1871. For our engraving of M. Faure we are indebted to L'Illustration.

M. FELIX FAURE, THE NEW PRESIDENT OF THE FRENCH REPUBLIC.

AN AMERICAN MACHINIST IN TURKEY.

THE late Warren Hidden was born in the city of New York, August 30, 1812 of English origin. His grandfather came from Hadden Hall, in Derbyshire, England, and settled in Vermont and served under General Washington in the revolutionary war; and his youngest brother, Lieutenant Henry B. Hidden, of the Lincoln cavalry, was killed at Burke's Station, near Fairfax Court House, Va., March 9, 1862, in a skirmish between a detachment consisting of fourteen dragoons under his command and about one hundred and fifty rebel infantry. See "The Rebellion Record," by Frank Moore, Vol. IV., page 55, and Doc. 84, page 282. His father, Enoch Hidden, a machinist, settled in New York. Among his inventions was that of the cannon lock, which was adopted by the United States; and afterward by the Russian government, through the efforts of His Excellency Baron Krudener, the Russian ambassador who was in Washington at that time.

Mr. Hidden left New York, October 12, 1832, at the age of twenty, and went to Constantinople on a sailing vessel, arriving there on Christmas eve of the same year. In accordance with the order of the Ottoman government, he entered the Imperial Arsenal, January 2, 1833, during the reign of the Sultan Mahmoud II, grandfather of the present Sultan, and served seven years, with several other Americans, under the supervision of the well known shipbuilder Henry Eckford. In 1831 Mr. Eckford sailed from New York for Constantinople in his beautiful vessel, known as a sloop of war, expecting to make a contract for the construction of vessels of war for the Turkish government, in the United States; the Sultan declined to make any contract for ships to be built abroad, but engaged Mr. Eckford to build them in Turkey. He accepted the offer, and sent to New York for skillful workmen. After his death Mr. Eckford was succeeded by Mr. Foster Rhodes, who had been his foreman; both of them were highly appreciated, and the latter received a brilliant decoration in the shape of a miniature vessel, which he was requested by the Sultan to wear every day. After a few years' stay in Constantinople Mr. Rhodes left of his own accord for America, with many valuable presents from the Sultan, and accompanied by all the Americans, except Mr. Reeves and Mr. Hidden, both of whom had married Russian ladies. Mr. Reeves a short while after left Turkey, Mr. Hidden remained in his position, and was the only American employed by the Turkish government until his death. He was an excellent machinist and electrician, and during his lifetime he made many improvements in the construction of vessels. The work on the frigate Nizaretteer the first war vessel built by Mr. Eckford, would have been stopped for better than three months on account of the lack of instruments for planking, if he had not invented a machine that answered the purpose, thus facilitating its construction. It must be remembered that there were no steamers at that time, for England or America, only sailing vessels, rendering communication slow and infrequent.

In the year 1835, during the administration of Damat Halil Pasha, minister of the artillery, Mr. Hidden invented and built a gun at Top-Hane, or the imperial gun factory, which fired twelve charges at once, which was first tried by Mr. Hidden at Caraatch in the presence of the courageous Sultan Mahmoud II, who stood a few feet from it. It was a great success, as well as a strange construction, and still exists at Top-Hane, and can be seen by any visitor. In 1836, he had invented six breech-loading rifle cannon models of different construction, which worked exceedingly well. The Capedan Pasha or minister of war, Tyher Pasha, hearing of these, sent for him, and as soon as he had examined them, praised the designs and workmanship, but said that it would not answer on a large scale. This of course discouraged Mr. Hidden, thinking that His Excellency Tyher Pasha must be a better judge than himself.

During the Crimean war, several English and German officers who were introduced by friends of Mr. Hidden were allowed to inspect them. About a year after this Mr. Armstrong constructed in England one precisely the same as those of Mr. Hidden; and Mr. Krupp, of Berlin, made another. If the Admiral Tyher Pasha had not made a mistake, but had ordered one of each to be placed on trial, Turkey would to-day have been in advance of all Europe, in regard to the implements of war.

In the year 1838 Mr. Hidden invented and constructed a rifled gun or carabine, which fired twenty-four balls in succession, flint lock, received powder, ball, priming, cock, and to shut the hammer, all in one motion.

The following anecdote is told concerning this gun. Mr. Hidden accompanied by Mr. Michael Tinghirian, interpreter of the Imperial Ottoman Arsenal, a refined Armenian, afterward employed in the same capacity in the mint, presented this carabine to Mehmed Bey, a chamberlain of the Sultan, who was astonished to hear that it fired twenty-four times, and without any examination he replied that a proper gun never fires more than twice, and that one made by a giaour or infidel must be a devilish invention: therefore he could not assist Mr. Hidden on any consideration to introduce it to the Sultan. This reply being interpreted to Mr. Hidden, annoyed him, and he said, "If the chamberlain wishes to see an infidel, let him look into the mirror." Finally it was presented to the Sultan Abdul Medjid, and still exists in Tchiraan Yalissi, one of the Sultan's beautiful palaces on the Bosphorus.

In April, 1839, Mr. Hidden went one day to the "Stamboul side" on personal business, and as he was unfamiliar with the Turkish language, was accompanied by the dragoman, or interpreter, of the arsenal, Mr. Tinghirian. During the reign of Sultan Mahmoud II it was customary to place two sentries at the Stamboul end of the bridge, connecting that place with Galata. They crossed this bridge and Mr. Hidden remarked to Mr. Tinghirian that the manner of one of the soldiers was very unpleasant, but Mr. Tinghirian, knowing Mr. Hidden well, advised him not to irritate him in any way. As they approached the spot, the soldier, perceiving that he was a foreigner and actuated by the hatred of all Christians which i an inheritance of the Turks, endeavored to hit Mr. Hidden on the head with his gun. He was about three feet from the soldier, and not relishing this rude compliment, at once snatched the gun from his hands, and in an instant this agile young American used the butt end upon the other soldier, who was coming to the assistance of his comrade, and knocked his musket to the ground. In this way he had taken both muskets and stood with his back to the side of the bridge, so that no one could pass behind him, and thus defended himself. At the same time Mr. Hidden sent Mr. Tinghirian to apprise his particular friend, Mr. Brown, the chief secretary and dragoman of the United States Legation, of the condition of affairs. By this time a great crowd of Turks had gathered around Mr. Hidden, among whom there was an elderly Mussulman officer, corpulent and fanatical in manner, with a heavy mustache dyed a jet black. He arrived at the spot a few moments after the occurrence, and learning from the bystanders of what had happened, began to curse and swear, drawing his semicircular sword in and out of its sheath boastingly, but meanwhile did not venture upon any overt act, for he was sufficiently wise to see that Mr. Hidden's determined manner and glance was not an ordinary one.

Among the crowd there happened to be a Greek officer of noble family, Comnenus by name, a man of fine stature and a native of Constantinople wearing a Turkish fez, who asked Mr. Hidden in broken English what his nationality was, and hearing that he was an American, advised him to make no resistance but to accompany the police quietly, at the same time offering to assist him in any way. The crowd hearing the conversation, and being inquisitive, asked the officer what language this giaour or infidel spoke, and learning that he spoke English and was a native of America, they were anxious to ascertain where America was, and whether it was a village in England, for they had never heard this name, but to their surprise Captain Comnenus the Greek officer spoke highly of the United States, and assured them that it is one of the great nations of the world. The Turkish officer, hearing this, was silent for a time, but continued to shake his head in revenge. Soon after this, a detachment of the police arrived. Mr. Hidden, accompanied by the Greek officer and followed by the entire crowd, having as a leader the Mussulman officer, went to the nearest police station. Upon their arrival the police captain tried to get some information from the crowd, whereupon the corpulent officer acted as a spokesman and fabricated an explanation, which was believed by nearly all; he stated that as he was passing by, the sentries presented arms as customary to their officers, and that Mr. Hidden, who was coming behind him, thinking that the soldier intended to strike him, snatched away his gun. The police captain, finding that Mr. Hidden could not speak Turkish, inquired if there was any one in the crowd who could speak this Frank's language. Captain Comnenus came forward and was obliged by the captain to ask Mr. Hidden to what nationality he belonged. Hearing that he was an American, the captain asked if they had any soldiers in his country. Mr. Hidden replied that the Americans had soldiers, and that they were not four-legged animals, but gentlemen. The police captain tried to substantiate the corpulent officer's story, but while this conversation was going on, the cavasse or policeman of the United States Legation, in full uniform, with Mr. Brown and Mr. Tinghirian, entered the police station and demanded from the police captain, according to the order of the American minister, the release of Mr. Hidden. The captain without hesitation complied with Mr. Brown's demand, and Mr. Hidden was released with many false compliments, leaving the crowd and its leader staring in amazement, and chagrined at losing its prey. A few days after Mr. Brown, with genuine American spirit, found out to which regiment these soldiers belonged. They were identified by Mr. Hidden and their officers gave proper satisfaction by their punishment. Other incidents similar to this might be related here. The limits of time and space will not permit.

In the year 1837 he married Miss Mary Theodore, a beautiful and cultured Russian lady and a native of Constantinople, by whom he had three sons and two daughters. His friend, Mr. Foster Rhodes, was the best man on this occasion, and the officiating clergyman was the Rev. Dr. William Goodell, well known as the first American missionary to Turkey. She was a loyal wife, a most devoted mother, and a consistent Christian. Mrs. Hidden died in Constantinople April 21, 1889, and previous to this had lost one daughter and a son.

At the beginning of the year 1840 Mr. Hidden was appointed chief machinist of the Imperial Ottoman Mint, located by the old Byzantine church of St. Irene, which is now used as an armory, and stands on the declivity between Seraglio Point and St. Sophia. The treasury notes or "Kaymes" issued by the Ottoman government until the year 1842 were written by hand, sealed by the Minister of Finance and by the director of the mint; the smallest denomination was $10. In 1843 he constructed the machinery for printing the notes, and in 1849 he invented a machine for stamping the imperial seal on the back of them. Only 10,000 per day could be stamped by the old process, the letters of the seal, being filled with ink, were almost illegible; but the newly-invented machine, a round table divided into six parts, worked with pedals, issued 150,000 daily, and the ink could be adjusted to a nicety.

When Mr. Hidden entered the Imperial Ottoman Mint, all the coin was stamped by hand. He and Mr. Taylor, an Englishman, the skilled government architect, were authorized to bring from England all the machinery for stamping coin, in consequence of which the Sultan Abdul Medjid made an important monetary reform. The standard of the gold and silver of Turkey is now the same as that of England.

At the completion of this machinery an exhibition of it was given in a specially decorated room at the mint, in the presence of Abdul Medjid and his suite. The first gold coin, a five liras piece, and the second of two and a half liras, the largest circulating denomination in goid, beautiful in design and workmanship, were finished and handed to the young Sultan for his approval. After having examined them, he presented them to Mr. Hidden in remembrance of the occasion.

The Sultan was pleased to bestow upon him the title "Effendi," or Sir, with the order of the "Nishan Iftihar," or the prize of glory, adorned with brilliants. This is very beautiful and is rare, as there are only three of them known to be in existence now.

As another recognition of his ability, the government gave him the charge of two other imperial Ottoman factories, viz.: "Fez-hane," for manufacturing Turkish fezes or caps, between Aivasary and Eyoub, and "Basmahane," or printing factory at Seraglio Point; but, finding the work too much, and not receiving his salary regularly, he resigned, and occupied himself entirely at the mint.

In an issue of the Evening Post, of New York, during the year 1848, an American correspondent signing himself D—— speaks of a visit to the Ottoman mint and eulogizes very highly the work of Mr. Hidden. He says: "The machinist of the Ottoman mint is a young American from New York, Mr. Warren Hidden, who performs his services at the mint with great skill and perfection. It was pleasant to us to hear our countryman thus spoken of, and it was evident that he commanded the respect and esteem of the director for his talents and steady habits alone. The director is an Armenian Catholic, a person of high respectability and considerable talents, who treated us with great kindness and attention."

Shortly after Mr. Hidden's appointment at the mint, the general director, Agop Bey Duz, being greatly pleased with his work, offered to make a contract with him for as many years as he might wish. Mr. Hidden replied that the promise of the director was a sufficient contract for him, which pleased Agop Bey Duz greatly. On the 1st of August, 1870, however, a contract was made between his successor, His Excellency Mihran Bey Duz, and Mr. Hidden for twelve years, expiring on the 31st of March, 1882. This contract, as well as the paper, the Evening Post, of 1848, still exist and are in the possession of his family. The contract is written on one side in French and on the other in English, and is signed by both parties. The above-mentioned Agop Bey Duz was descended from a noble family and was appointed by Mahmoud II, general director of the mint; a short time after his four brothers were killed by the order of the Sultan through the injustice and the intrigues of others. Two of them were beheaded, the other two were hung outside the windows of their own house at Yenikeni, on the Bosphorus, and their property was confiscated. Agop Bey Duz died in 1853 and was succeeded by his nephew, Mihran Bey Duz, son of Serkiz Duz. See "Description of Constantinople," by Scarlato Byzantius, Vol. II, page 143.

At one time during the summer of 1866, Mr. Hidden was at the residence of Mihran Bey Duz, in the village of Kuru-tchesme, on the Bosphorus, supervising some private mechanical work for him. As he was completing it his host approached him and taking off his own gold watch, with its long chain, slipped the latter quietly on his neck in recognition of his services. In 1841 Mr. Hidden visited Athens, but was soon recalled by the Ottoman government on account of pressing work in the mint.

During the Crimean war he invented a conical shell which would explode in soft earthworks. It was used by the minister of the artillery, Halil Pasha, proving to be of great excellence.

In 1853, during the reign of the Sultan Abdul Aziz, a national exhibition was opened in the At-Meidan or Hippodrome, in which he exhibited several brass guns of his work. A French newspaper, named Journal de Constantinople, spoke highly of him and his inventions. At the close of the same year he visited Paris and introduced an invention for sinking ironclads to the French government, through the Duke de Morny. Mr. Hidden afterward constructed and presented to the reigning Sultan, Abdul Hamid, a gun of excellent workmanship, firing 400 balls, a self-charger, with spy-glass for picking up officers at a great distance. It was gratefully accepted and placed in the palace of Vildiz. As a token of his appreciation the Sultan gave him the order of "Osmanie," or military prize. The finances of Turkey have always been in an uncertain condition. Even the employes of the government found it difficult to get what was due them. Mr. Hidden, who was one of the officers of the mint, had to resort to a ruse in order to collect his salary. One of his duties was to keep the scales in which the bullion was weighed correctly adjusted. One day, knowing that the director, Mihran Bey Duz, and suite were coming to weigh the bullion borrowed from England, he quietly put the scales out of adjustment. When the director discovered their condition he appealed to Mr. Hidden, who said that his mind was in such a chaotic state that he was incapable of setting them, owing to the anxiety incident to the need of money. The director, who was his friend, saw through it and asked him up to the office, where he paid him part of the many months' salary due, after which Mr. Hidden went to the weighing room and very soon had the scales correctly set. It should be said in explanation that the failure of Mihran Bey Duz to pay the employes of the mint was not occasioned by an unwillingness to do so, but simply because no funds had been placed in his hands by the minister of finance for that purpose. The payment made to Mr. Hidden was, therefore, on his own responsibility.

Owing to the financial difficulties of Turkey, the director of the mint, Mihran Bey Duz, resigned, for it was impossible for him to meet the expenses of the mint on so small an allowance from the minister of finance, and was succeeded by Tewfik Effendi, a Turk, who was ignorant and totally unqualified for its administration. The directors of the mint had been Armenians, who had received a special training in Europe for this purpose, and the position had become hereditary to this race since 1818. In 1829 Kazaz Artin, a prominent Armenian resident of Constantinople, saved Turkey from the monetary crisis caused by the payment of an enormous sum as a war indemnity to Russia. The government treasury was empty and Sultan Mahmoud II was in despair, for it was utterly impossible for him to procure it; but, through the ingenuity of Kazaz Artin, who raised a loan from the Armenian bankers of Constantinople, the amount was paid to the Russians. The money was soon after returned to these bankers in "Beshlik," a coin composed of copper and silver, of which very little is now in circulation.

Tewfik Effendi took a very unwise and unsuccessful step in the early part of his directorship of the mint. He tried to cut down the salaries of those employed in it, which before and since then were irregularly paid. Mr. Hidden would not consent to this reduction, after

many years of faithful service, especially as his salary was already largely in arrears, and consequently sought the advice of Mr. E. Joy Morris, formerly minister plenipotentiary from the United States to the Sublime Porte at Constantinople, and once a senator, representing the State of Illinois, a fine linguist.

In 1881 he received in reply the following letter from Mr. Morris, the original of which exists:

837 NORTH BROAD ST., PHILADELPHIA, June 17, 1881.

WARREN HIDDEN, Esq.

Dear Sir: I have received the statement of your grievances against the administration of the mint at Constantinople. Gross injustice is done you, and were I minister to Turkey, I would do all in my power unofficially to procure you satisfaction. Private citizen as I now am, I cannot serve you. Interference on my part at Washington would not be proper. If you can have a confidential and private interview with the new minister, Gen. Lew Wallace, I am sure he will support your claim. Should he decline to meddle in the matter, a reference of the whole subject directly to Mr. Blaine, Secretary of State, might be expedient.

During my residence at Constantinople I had frequent intercourse with you, and I formed a high idea of your inventive genius and of your sterling qualities as an American citizen. Very truly yours,

E. JOY MORRIS.

While General Lew Wallace was minister plenipotentiary from the United States to Turkey, he enjoyed to a large degree the friendship and confidence of the Sultan, and by his kindness in speaking to him personally, concerning this matter, it was settled at once, and at the same time the Sultan Abdul Hamid II gave the order that Mr. Hidden should continue to hold his position during his lifetime, and to be treated as a Turkish officer.

During the term of office of Mr. Morris, in Constantinople, complaint was made to him by Mr. Hidden on the same subject. Being a warm personal friend of Ali Pasha, the grand vizier, Mr. Morris remonstrated with him in regard to the injustice done to this faithful officer of the mint; he immediately sent an order to the minister of finance to pay Mr. Hidden all the arrears due him. When Mr. Hidden went to the minister of finance and presented his bill for services rendered, that haughty functionary offered him a part of the amount, but Mr. Hidden refused, saying he had been promised all of it, which was reluctantly paid to him. As he left the office he was followed by a messenger, bearing a letter from the minister of finance to the director of the mint, Mihran Bey Duz, ordering him to dismiss this independent American immediately. The director replied: "I will carry out your instructions at once, provided you will send me a man as capable and as well qualified to take the position." The friendship existing between Ali Pasha and Mr. Morris has been referred to. A great compliment was paid to the American minister by this accomplished diplomat, when he went to bid him farewell at the time of his return to the United States. The Grand Vizier Ali Pasha shook hands with Mr. Morris most warmly, and said: "You are an honor to your country and to your countrymen."

Tewfik Effendi was succeeded by Reshid Effendi, an elderly man and of strict business habits, formerly director for many years of the custom house in Smyrna, and decorated by several European powers for his honorable dealings with all—a strange thing among the Turks. When he was appointed general director of the mint, being inexperienced in its administration, he wrote to the ex-Director Mihran Bey Duz, for information. The ex-director gave him the desired instruction, and concluded his letter by saying that, for any further assistance, he would refer him to the oldest employe, Mr. Hidden, whom he recommended highly. At the time of Reshid Effendi's appointment, Mr. Hidden was indisposed and had not visited the mint for several days, and, to his surprise, he was told that a messenger from the mint was awaiting him. Mr. Hidden received him in his private room, and was told that the newly appointed director wished to see him at his house at Ak-Serai, in Stamboul, on the first Friday afternoon after he was able to go out. In due time Mr. Hidden complied with his request, and visited the director. He was cordially received by Reshid Effendi, who assured him of his friendship, and made many personal inquiries concerning the employes of the mint.

In 1855 and 1865, the ravages of the cholera in Constantinople were appalling. Hundreds died daily, but Mr. Hidden saved the lives of many Christians and Mussulmans, through a valuable antidote of his own preparation, and composed of six ingredients. There is no better remedy known than this for cholera and similar diseases. It is taken internally and is also applied externally. He was liberal, courageous, and always ready to help others. An instance of his courage is as follows: A Greek lady of remarkable beauty eloped with a young Turk, but on account of his brutal treatment, was afterward compelled to leave him secretly, and was sent by her friends to Athens, where she married a Greek. In the meantime, it was rumored that her four sisters, who were also beautiful women, were in danger of being abducted by the Turks, which could be easily done, and it greatly alarmed the family. Her two brothers applied to Mr. Hidden for advice and assistance, as they knew him well. He at once went to their house and took the four daughters, with their aged parents, in disguise, at night, to his own home, where they remained secreted for a month. Mr. Hidden advised the two sons to procure a house in a Greek settlement a few miles distant, where they would be entirely safe, and to remove the family thither, which was done.

In 1860, the Greek teacher of the village, Beshiktash, with the chorister of the Greek church, went together on horseback, to a theater in Pera. It was growing dark, and as they passed the palace of Dolma-bagtche, in full gallop, they knocked down a eunuch belonging to the Sultan's harem. Being greatly frightened, they determined not to go to the theater, but to return home by another route, and to hide themselves. At once they apprised Mr. Hidden through the mother of the teacher, of their trouble, and he hastened to help them, as the Turkish authorities were already looking for them. The same night he took two of his own high hats to his friends, thus disguising them, as they had always worn the red Turkish fez, and he insisted upon them accompanying him to his home, where they remained five weeks. Fortunately, the eunuch recovered, and the local authorities could not ascertain who were the guilty ones.

During the revolution of 1867 in the island of Crete a committee of Greeks was formed to help the Christian insurgents, who were trying to obtain their freedom by throwing off the cruel and almost unbearable yoke of Turkey. This committee had printed a large number of maps of Crete, to be distributed among the Greeks in an appeal for funds. The circulation of these maps was strictly prohibited by the Turkish government. The committee applied to different Europeans to sign the maps, so that in case the distributor should be arrested by the government, the signature would be a sufficient proof that it belonged to a foreigner. Unfortunately, no European would comply with their request, because of the trouble that might ensue. At last, application was made to Mr. Hidden, who readily consented to do anything that might assist them to get their liberty, and the maps were distributed without any trouble.

In 1878, Mr. Hidden visited his native land, and after a few months' stay in New York, he returned to Constantinople. It is a remarkable fact that, during his absence, his salary was continued by the Turkish government, which was entirely unprecedented.

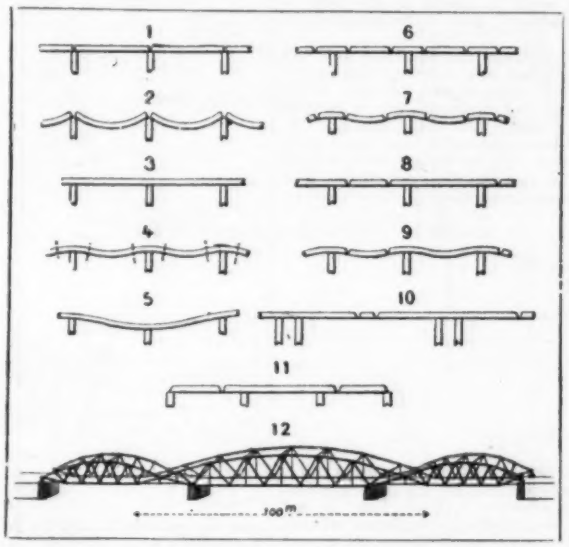
He served five sultans: Mahmoud II, who reigned until the year 1839; Abdul Mejid, whose reign extended until 1861; Abdul Aziz, until 1876; Murad V, who reigned only three months, and his successor, Sultan Abdul Hamid II, who is the reigning sovereign of Turkey. After a long and useful life, and apparently while in the full vigor of manhood, Mr. Hidden died on the 2d of December, 1888, after an illness of three days. He conducted his business with great fidelity, ability, and ingenuity. Although a loyal American citizen, he was so familiar with the Turkish language, manners, and customs, that he was often taken by the Turks for one of their own nationality. His remains rest in the Anglo-American cemetery at Ferikeui, in the suburbs of Constantinople.

After his death, all the principal papers in Constantinople, the French, Armenian, and Greek, including the leading official Turkish journal, titled Servet, dated December 10, 1888, spoke highly of Mr. Hidden's ability, honesty, and integrity. N. W. H.

THE TOLBIAC STREET BRIDGE AT PARIS.

WE have a bridge to construct in order to cross an open space. The use of arches is prohibited by the hypothesis, and the space is too wide to be crossed by a single span. We establish a series of piers, and, from one to the other, throw a rigid flooring without any connection being made between the successive platforms. This is the bridge with independent spans (Fig. 1). Under the effect of a load, for example, of one uniformly distributed over the length of the bridge, the platforms take the form indicated in Fig. 2, where the changes in level are much exaggerated. If a slight change of level of the bearing points occurs, certain spans will slightly incline, but without becoming distorted and without the tensions or pressures at the various points being sensibly modified.

In order to increase the resistance, bridges with interdependent spans have been conceived—a single platform, all in one piece, resting upon all the bearing points (Fig. 3). Fig. 4 shows how such a platform becomes distorted. The figure supposes that we are in the middle of a bridge comprising a large number of equal spans, and that the load is uniformly distributed over the length and equal to that that has caused the distortion shown in Fig. 2, the girders in both cases having the same constant section. Such a bridge is more rigid, and all things equal, moreover, may be of lighter construction than one with independent spans. But let us suppose (Fig. 5) that for some cause or other a bearing point is not at the level anticipated. The distortion of the platform will no longer be that upon which one reckoned, and grave miscalculations might result therefrom. In the usual cases there would suffice a change of level of a few fractions of an inch and often less. Between interdependent and independent spans opinions are divided.



FIGS. 1 TO 12.—DIAGRAMS OF THE CONSTRUCTION OF A BRIDGE.

Let us remark (Fig. 4) that in our distorted interdependent spans there exists a series of points where the curve changes direction. Let us divide our girder at these points (Fig. 6), and suppose the various sections connected by simple joints. Under the influence of the same load uniformly distributed, we obtain a distortion (Fig. 7) identical with those shown in Fig. 4. Such a work would evidently be very unstable. In order to render it stable, let us diminish the number of divisions (Fig. 8). Under the effect of the same load uniformly distributed, we shall have (Fig 9) the same distortion already represented in Figs. 4 and 7. But a slight change of level of the bearing points will have merely the effect of slightly inclining each girder without distorting it and without changing the conditions of work of its different parts. It is, upon the whole, the bridge with independent spans, without the compulsion of making the bearing points correspond with the extremities of the girders. This was done in the first place because it corresponded to a simpler construction, but it is in no wise obligatory. In rejecting the method, we obtain a work that has the flexibility of the bridge with independent spans and the resistance of the bridge with interdependent ones. In practice, under the effect of irregularly distributed loads and with girders of variable section, things are no longer so simple, and the advantages are less marked than this summary theory indicates.

In the case in which the dimensions of certain parts are exaggerated at the expense of others, we obtain

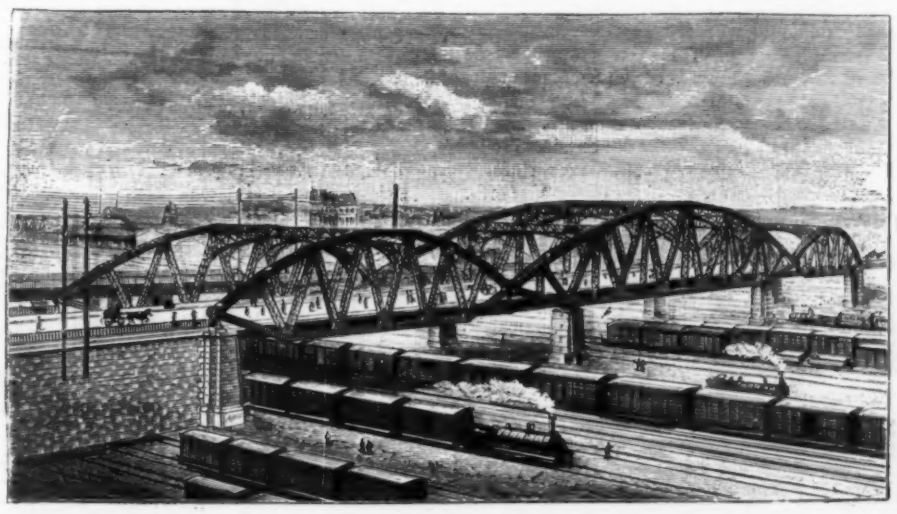


FIG. 13.—THE TOLBIAC STREET BRIDGE AT PARIS.

(Fig. 10) the diagrammatic arrangement of the Forth bridge. But here one has been guided by other considerations, and especially an endeavor has been made to reduce the scaffoldings and make it possible to construct the greater part of the work in cantilever form.

Fig. 11 gives a diagram of a complete application of the principles that we have just indicated. It is the bridge that is now finished at Paris and by means of which Tolbiac Street is to cross the tracks of the Orleans station. Figs. 12 and 13 give a diagram and a general view of this finished work. The somewhat odd and unusual form well exhibits the ideas that have guided the author of the project. A central truss extends beyond the two piers. Two end trusses rest, through joints, on the one hand upon the abutments and on the other upon the ends of the central truss. These end trusses are a little higher than would have been necessary from the view point alone of resistance to loads and also from that of the harmonious aspect of the work, but in order to resist the wind it was necessary to provide cross bracing at the top of the two neighboring trusses and leave beneath the bracing a sufficient height for the passage of the cars. Hence, a slight increase in height of the lateral trusses. The central span and one of the lateral ones that were in place at the time of the hurricane of November 17 last victoriously withstood the assault.

The cross pieces that support the roadway and rest upon the principal girders are here of the exceptional length of 55 feet, necessitated by the width given Tolbiac Street and the impossibility of having them rest upon more than two main girders. In most cases, these pieces are assembled in a rigid manner with the main girders. Under the effect of a load, the piece bends and tends to twist the main girder (Fig. 14, right side); and hence, somewhat ill-known reactions. In the Tolbiac Street bridge, the cross piece rests upon the main girder through the intermedium of a joint. Under the effect of a load (Fig. 14, left side), it will become more distorted with equal section, but will not exert any torsion upon the main girder.

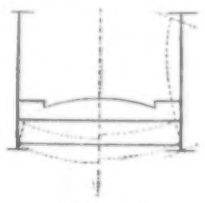


FIG. 14.

In view of the unusual dimensions of the bridge pieces, the author of the project has preferred, even at the cost of a slight increase in weight, to guard against reactions whose effects it is practically very difficult to calculate.—La Nature.

[FROM ENGINEERING.]

STEAM LIFEBOATS.

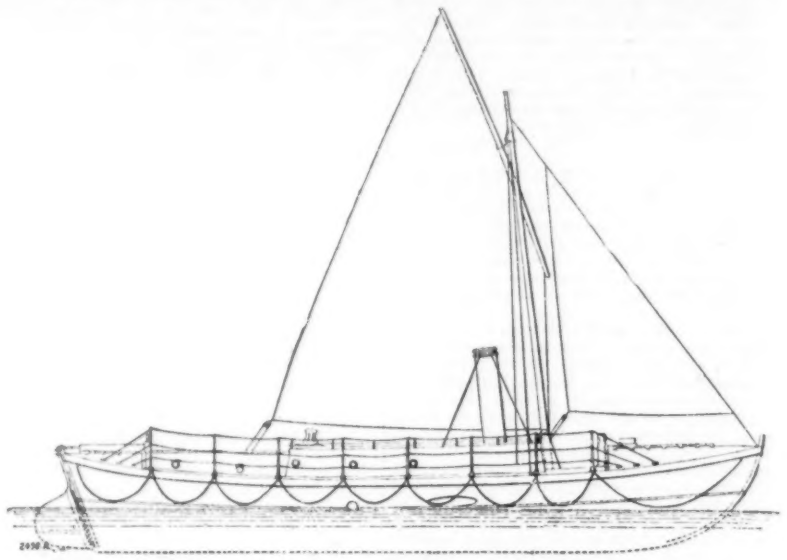
IT has long been recognized that the possibilities of service of the Royal Lifeboat Institution could be greatly increased, eminently satisfactory as these services are, if on the more dangerous parts of the coast steam lifeboats could be substituted for the sail and rowing boats, which in a high sea, when they are mostly needed, can only be worked with extreme difficulty. But the conditions were against the use of paddles or screw propellers, as the pitching of the boat would have involved racing so frequently that the engines might at the critical moment give way. The attention of the board was thus directed to trials of jet propulsion, and in December, 1890, a boat was designed and completed by Messrs. R. & H. Green, Blackwall, for the institution. This was the first mechanically propelled lifeboat built, and the success attained has solved the problem. The first boat, named the Duke of Northumberland, is 50 feet long, 14 feet beam, and her loaded displacement at 3 feet 6 inches draught is 26 tons. Her propelling machinery, constructed by Messrs. Thornycroft, consists of a horizontal compound surface condensing engine of about 170 horse power, driving a nearly horizontal turbine of 30 inches in diameter, which delivers its water through two outlets in the sides of the boat, and draws its supply through a vertical scoop-shaped inlet amidships. The boiler is of the Thornycroft water tube type, with a heating surface of 606 square feet, and grate surface of 8½ square feet. This boat, after going through an exhaustive series of trials, making during one of them the passage from Harwich to Holyhead, a distance of 1,000 miles, without the least mishap, was eventually placed on the station at Harwich, and has since done excellent service in the saving of many lives and much valuable property.

The experience gained was most satisfactory, and probably the reason why the institution has not added more such vessels to their fleet than the City of Glasgow has reference only to finances. This second and improved steam lifeboat, for there is no question of improvement, is the outcome of the liberality of the people of Glasgow, who, recognizing the utility of the new type of lifeboat, decided, by instituting a "Lifeboat Saturday" each year, to present the institution with the new vessel. We hope that the details and illustrations of the new vessel which we now give may induce other cities to do likewise.

Although designed in Glasgow, by Mr. G. L. Watson, of yacht designing fame, the vessel has been constructed in London, and very properly so, for the experience gained in building the Duke of Northumberland has given a better and cheaper boat; although larger, the new boat cost but £3,500, or £1,500 less than the prototype. The new vessel differs from the earlier vessel, besides being larger. In addition to having two jets for forward propulsion and for astern propulsion, like the first boat, the City of Glasgow is able to throw a jet from the broadside which gives lateral propulsion, and this buffer will enable the lifeboat to throw herself broadside off a ship. This is a great gain, for the lifeboat is often in imminent danger of being dashed against a ship or wreck.

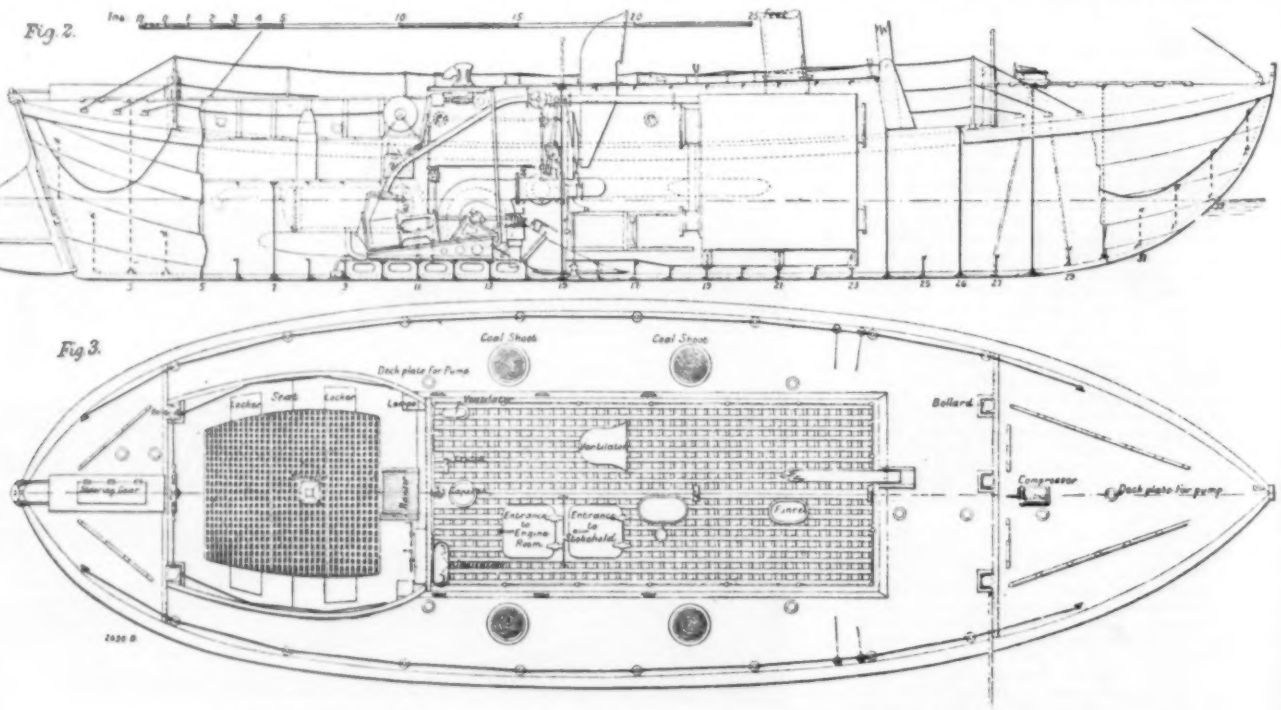
Again, instead of propulsion being dependent, as in the case of the Duke of Northumberland, upon one horizontal turbine and inlet to feed it, the new vessel is fitted with two vertical centrifugal disconnecting pumps placed on the starboard and port sides, driven direct from the crankshaft—to which they are coupled and co-axial—of an inclined compound direct action engine of 200 horse power. The buoyancy of the new vessel has been very carefully considered, and to add to her safety she is divided into no less than 13 watertight compartments, by longitudinal and thwartship bulkheads; moreover, should one of these be stove in, provision is made to connect it with the centrifugal pump inlets, so that the inflow of water would be utilized for the boat's propulsion.

The City of Glasgow is 53 feet long by 16 beam, 3 feet longer and 2 feet more beam than the first boat, while the depth is 5½ feet. The displacement is 30 tons, as compared with 26 tons, while the draught, as a result of the greater beam, is less by 3 inches, being 3 feet 3 inches. She has thus greater carrying power, and will accommodate in the cockpit (Figs. 2, 3 and 6) 30 to 40 passengers, while having on board 4 tons of coal and half a ton of fresh water in the reserve tanks. The model is very fine, the area of the rudder noticeably large, while deep bilge keels of American elm have been fitted. The floor is flat. She is constructed for the most part of galvanized steel. The dimensions of plates, frames, decks, etc., are given with details of construction in the sections (Fig. 6). There is a double bottom under the boiler and engine spaces (Fig. 2). The general appearance of the vessel is shown by the engravings, and the details of the deck structures on Figs. 2 and 3, so that it only need be mentioned here that the vessel carries sails for cruising, as shown on Fig. 1.



STEAM LIFEBOAT CITY OF GLASGOW.

The machinery is probably the most interesting feature of the boat. It was constructed by Messrs J. Penn & Sons, Limited, Greenwich, and is illustrated in detail. Hall's patent water tube steam generators are used. Unlike most other designs, the boiler has two steam chests on the top, as well as two water drums below. The former are 16 inches inside diameter, placed at 1 foot 10 inch centers, and the latter 8½ inches. The steam generating tubes pass diagonally from the right water drum up to the left steam chest. This arrangement allows of the escape of the products of combustion between the upper or steam chambers into the funnel, thus utilizing as far as possible the effective heat of the fuel. The tubes on the extreme wing act as downcomers in the process of circulation. The tubes are all of steel, and are 1 inch in diameter. Another feature is that the steam pipe on its way to the engine passes through the uptake of the boiler for the purpose of drying the steam. The boiler is 7



JET PROPELLED STEAM LIFEBOAT CITY OF GLASGOW.

Fig.4.

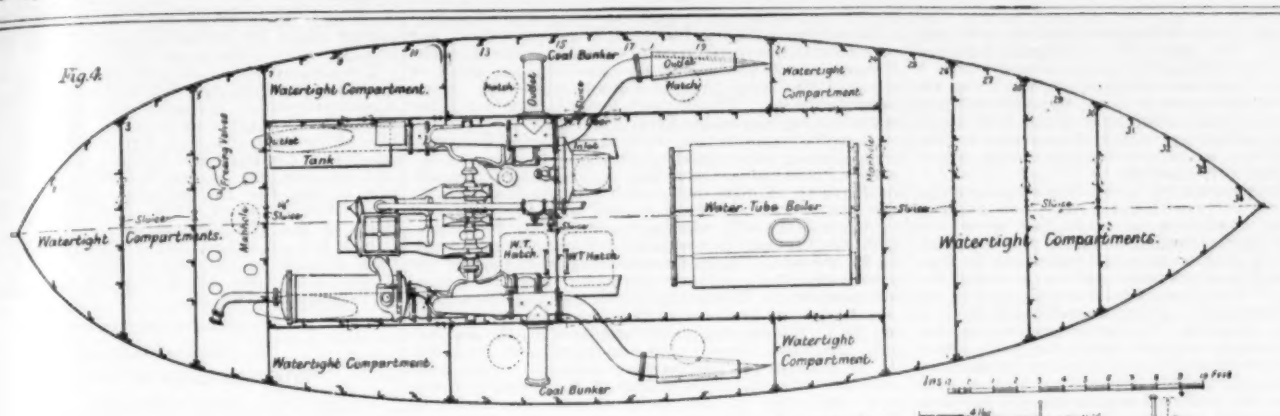


Fig.5.

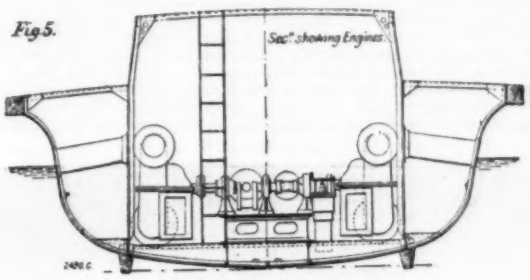


Fig.6.

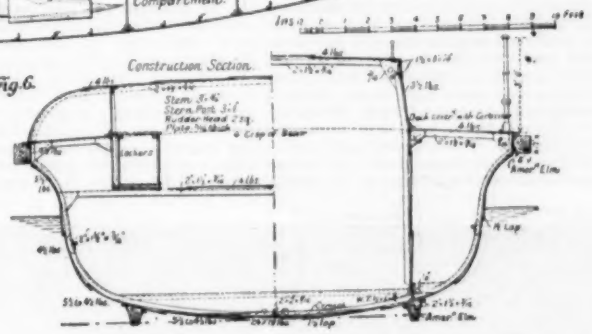


Fig.7.

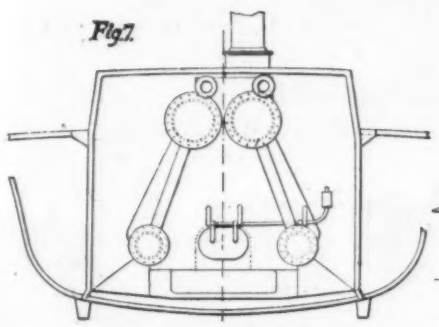


Fig.8.

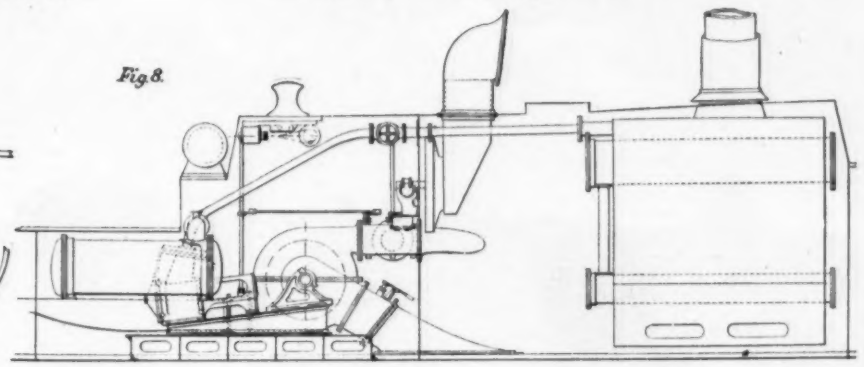


Fig.9.

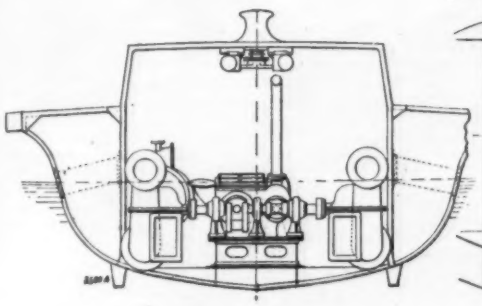


Fig.10.

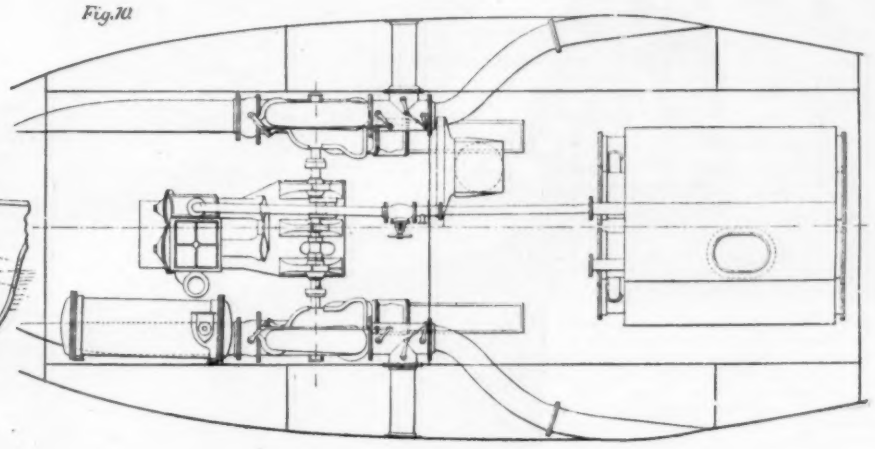


Fig.11.

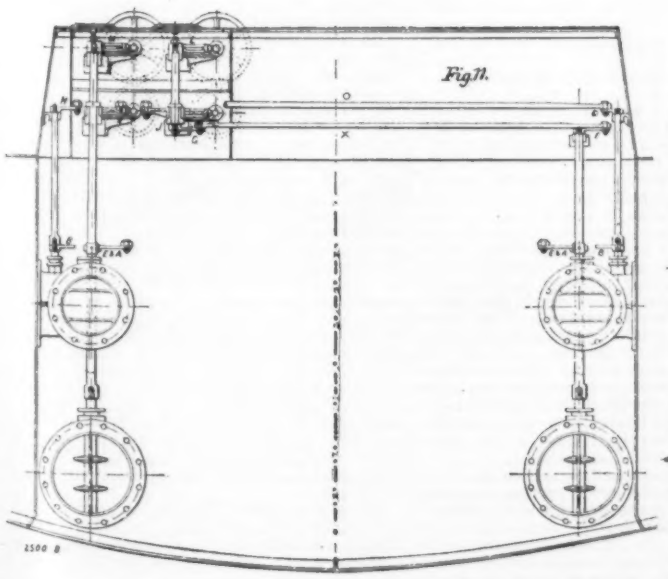
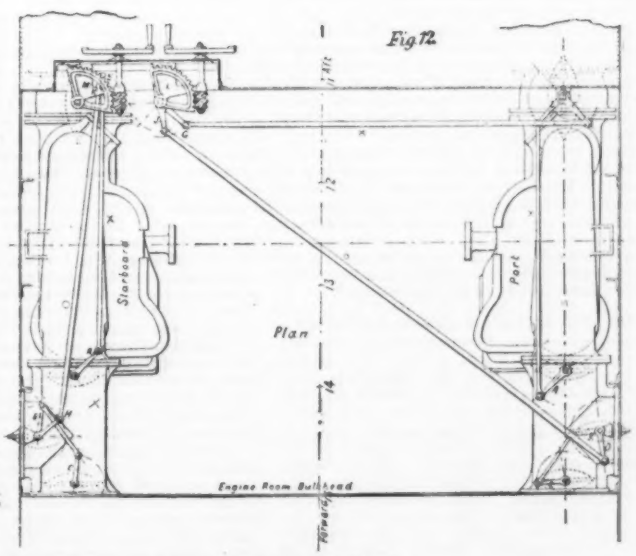


Fig.12.



JET PROPELLED STEAM LIFEBOAT CITY OF GLASGOW.

feet 7 inches long, and the firegrate 5 feet ¼ inch long by 3 feet broad. The grate area is 15 square feet, and the heating surface 712 square feet, a ratio of 1 to 47·5. The power developed with 2 inches air pressure in the closed stokehold was equal to 15 indicated horse power per square foot of grate area, there being 3·16 square feet of heating surface per indicated horse power. The boiler is placed in a separate watertight compartment, as shown in Figs. 4, 7, 8 and 10.

The propelling machinery is of Green's patent hydraulic type. Two centrifugal pumps, one on each side of the boat, are driven by an inclined direct acting compound engine, worked by steam of 150 pounds pressure. The general arrangement is shown in Figs. 2, 4 and 5. Each pump is fitted with two outlets, one ahead and the other astern; the astern outlets are also fitted to discharge in an athwartship direction, as shown by Figs. 4 and 10. The inlets are rectangular, 8 inches by 17 inches, and the outlets for going ahead 12 inches in diameter, and for going astern or laterally, 9 inches in diameter. Throttle valves worked from the deck direct the outflow fore and aft, and are connected on each side respectively, one closing as the other opens, the boat becoming stationary when both ahead and astern outlets are open half way. Figs. 11 and 12. The athwartship discharge acts very efficiently for a sideways movement, keeping the boat from too near an approach to danger. The engines have cylinders 8½ inches and 15 inches in diameter by 12 inches stroke, while the turbines are 2 feet 6 inches in diameter. The engines are fitted with a brass surface condenser and air pump worked off the crankshaft. The feed pumps are of Worthington type and are duplicated—one in engine room and one in stokehold. A feed tank is also fitted to carry an extra supply of fresh water. A bilge connection is provided on one centrifugal pump for special use. The entire weight of the machinery is 10 tons. The engines developed on trial a maximum of 225 indicated horse power, the contract being for 200 indicated horse power.

As to the steaming trials, it may be interesting to give the results of the three hydraulic propelled lifeboats so far built. The first, the Duke of Northumberland, we have already referred to. She had compound engines and one turbine and Thornycroft boilers; the other two are practically alike, with compound engines and two turbines; one was the City of Glasgow and the other, the President Van Heel, has been built for the Lifeboat Institution of South Holland.

DIMENSIONS AND TRIALS OF STEAM LIFEBOATS.

		Duke of Northumberland.	City of Glasgow.	President Van Heel.
Cylinders	Inches	8½ and 14½	8½ and 15	8½ and 15
Stroke	"	12	12	12
Diameter turbine	"	30	30	30
Heating surface	sq. ft.	606	712	810
Grate area	"	8½	15	18·8
Steam pressure	pounds	129·7	150	150
Air pressure	inches	2·1	2	2
Revolutions		435	400	405
Indicated horse power		186	225	230
Speed	knots	8·18	7·75	8·2

Experience with the Duke of Northumberland has proved that the speed in a heavy sea is quite as satisfactory as on the measured mile, and that she can tow a boat at the same speed as if going alone, the power being the same. The two new boats, it may be further stated, can steam under natural draught.

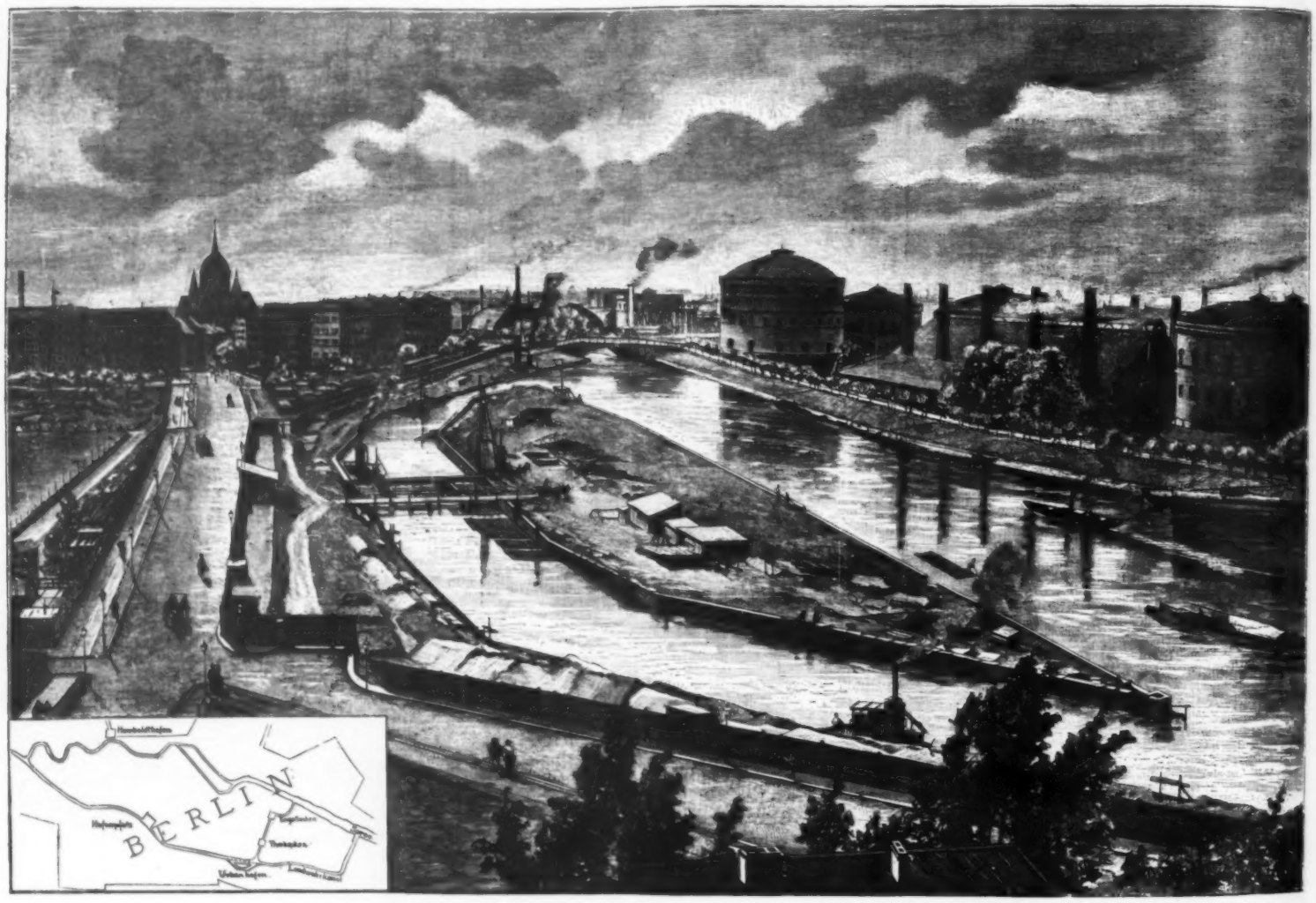
As to the maneuvering trials of the City of Glasgow, one jet going astern enabled the boat to turn a complete circle without the rudder in 5 minutes 5 seconds in the open off Sheerness, with a wind force 6. At the same time the craft turned with the rudder in 1 minute 26 seconds, with both jets driving her ahead. Going full speed, she stopped dead and started astern in 20 seconds. Other maneuvering tests showed the vessel steady in a heavy seaway. The trials were attended by Sir Edward Birkbeck and the directors of the Royal Lifeboat Institution, by Captain Nepean, Mr. G. L. Watson, the naval architect of the institution, Mr. J. F. Green, of the builders' firm, and Mr. J. P. Hall, of the engineering company. All were satisfied with the great utility of the vessel. She is now stationed at Harwich, whence the Duke of Northumberland has been removed to New Brighton. The latter, during the gale of December 23 and 23, was out several times and saved three lives, while in her three years' service she has been out 28 times and saved 51 lives. The difficulty which was apprehended by many when the craft grounded on sand has not been experienced, great care being exercised. The chief engineer, Mr. A. Simmons, who has been out on all occasions, has been awarded a medal by the institution for his services.

THE NEW URBANHAFEN, BERLIN.

IT is a fact not generally known that there is more shipping on the Spree (on the banks of which the former fishing village has grown to be the capital of the empire) than on any other river in the interior of Germany. Fifty thousand vessels carry 618,750 tons of freight on it each year, and Berlin is, of course, the center of this business, which is divided within the precincts of the city between the river itself, the old branch and the canals at the right and left of the Spree. When the southern canal was constructed, a harbor (hafen) was built about midway between the railroads from Magdeburg and from Leipzig and Halle, which gave its name to the Havenplatz. Two other large basins with dock accommodations have been arranged on an intermediate canal that connects this canal with the Spree farther eastward. On account of the increasing traffic on this waterway there was more and more demand for the erection of a fourth large harbor by the city, and this harbor is now approaching completion. It has been named from the neighborhood in which it is situated Urbanhafen.

It can easily be understood that great changes have been made in the banks of the river by this immense new undertaking. The bank that was formerly covered with coal dust and lined with shanties and wood yards has been dug out to widen the waterway into a five-sided basin, a similarly shaped island having, however, been left in the middle, which is to be provided with steam cranes and warehouses, thus making an excellent place for unloading and storing freight. A bridge connects this island with the bank.

The accompanying illustration (for which we are indebted to the Illustrirte Zeitung) shows the basin in its present condition, giving a clear idea of the whole work and its position in the city. An interesting picture of the work of man is spread before the eye of the spectator; the Baerwald Bridge is seen in the distance and on one side, among the smoking chimneys and piles of coal, rises the gasometer, looking like a mediæval Moorish tower, while on the other side is the dome of the Heiligkreuzkirche, which was finished only a few years ago, but is already blackened. All that remains of the former quiet country is a few clumps of old trees, which help one to realize the wonderful growth of the city.



THE NEW URBANHAFEN, BERLIN.—DRAWING BY H. ULBRICH.

[FROM THE ENGINEER.]

THE SIMPLON TUNNEL.—III.*

VENTILATION After Completion.—The ventilation of a single-line tunnel more than twelve miles long cannot be allowed to depend entirely on variations of atmospheric pressure; though in the longest existing tunnels these are considered sufficient to establish currents and to change the air. It might occasionally happen that natural ventilation ceased completely, and consequently all the smoke from the trains would collect in the tunnels and might vitiate the air very seriously. Consequently it is necessary to arrange for artificial ventilation at the Simplon Tunnel.

(15) Products of Combustion and their Effects on the Air.—In burning coal, several gases are produced which are injurious to health when they are mixed in any quantity with atmospheric air. Of these deleterious gases, carbonic acid is by far the most important, as, compared with it, the other products of combustion exist in comparatively small quantities. Of the others which are formed, there are only two which can have a pernicious effect—carbonic oxide and sulphurous acid. According to Rubner, there is no bad effect from breathing air containing 0·02 per cent. of carbonic oxide; and Gruber gives 0·05 per cent. as the probable limit at which this gas becomes pernicious. With good combustion, only one volume of CO should be formed for 100 parts of CO_2, so that when the air contained 1 per cent. of carbonic acid there should only be 0·01 per cent. of carbonic oxide present, or one-fifth of the lowest quantity considered injurious. Sulphurous acid is still less important. Supposing that the coal used in the locomotives contained as much as 2 per cent. of sulphur, the proportion of SO_2 to CO_2 would be about one to a hundred; thus 1 per cent. of CO_2 would give 0·01 per cent. of SO_2, a quantity not worthy of consideration. To this may be added that, as the air of tunnels is always humid, the sulphurous acid is rapidly oxidized and precipitated on the walls.

According to Prof. Rubner, V. Pettenkofer and other authorities, human beings lose consciousness and die almost immediately in air containing 30 per cent. of carbonic acid; but minute quantities, such as usually

* Continued from SUPPLEMENT, No. 999, page 15962.

exist in atmospheric air, have no ill effects, and it was proved at the construction of the Gothard Tunnel that men could not only exist for hours, but work hard, in air containing 1 per cent. of carbonic acid. In English coal mines Angus Smith gives 0·785 per cent. as the medium and 2·73 per cent. as the maximum, which he found in a large number of investigations. The general opinion seems to be that air containing not more than 1 per cent. may be considered quite fit to breathe, and that air which contains a greater quantity may be breathed with impunity during several hours.

It must be noted that this only refers to pure carbonic acid. In works on ventilation a limit varying between 1 and 3 per mil is usually considered the point beyond which the air of rooms or workshops cannot be vitiated without becoming unhealthy. But in these cases the air is vitiated, not by the carbonic acid, but by impalpable and imponderable exhalations, whose proportion and chemical constitution are equally unknown. It is only by their toxic effects that their presence is known, but it is found that they are exhaled proportionately with carbonic acid. It is not, therefore, that more than 3 per mil of carbonic acid is deleterious, but that, when given off by human beings, it shows that other and more noxious substances are present in an excessive quantity. In a tunnel the carbonic acid is caused by the combustion of coal and not by human breath. If there should be 100 platelayers employed, each exhaling 1 cubic foot of carbonic acid per hour, this, diluted by the 1,750 cubic feet of air forced in every second by the fans, would not make one-twentieth of the proportion which could be considered harmful. This may, therefore, be disregarded, and the carbonic acid caused by combustion be the only consideration. This being the case, 1 per cent. is perfectly safe, and even 2 or 3 per cent. for short spaces of time—a quarter to half an hour—would do no harm.

(16) Different Methods of Ventilation and Appliances to be Used.—When the tunnel is at work, the same apparatus will be used for ventilation as during construction. At each end of the tunnel there will be two fans, which can either draw air from or force air into the tunnel, and can either work separately or together. When working together, they can either be coupled in quantity or in tension. Thus, each fan can give 1,750 cubic feet of air per second at a pressure of 9¾ in. water; therefore, when coupled in quantity, the two fans will give 3,500 cubic feet; but when coupled in tension the supply will be 1,750 cubic feet, at a pressure equal to 19½ in. water. There are three different manners in which the ventilation can be carried out. First, air can be passed through the parallel heading into the tunnel, in the same way as during construction. Secondly, 1,750 cubic feet of air can be forced into the north end of the tunnel and pass through it from end to end. Thirdly, the ventilation can be done in the opposite direction, from south to north. The first of these methods can only be adopted while No. I tunnel is alone being worked. Directly No. II is finished and open to traffic, trains will only go through it from south to north, while No. I will only be used by those proceeding from north to south. It will, therefore, be necessary to ventilate each of these tunnels separately, either by the second or third method. After due consideration, it has been decided that the following arrangements shall be adopted: (1) As long as only No. I tunnel is open to traffic, 1,750 cubic feet of air shall be introduced into the north end per second, and the entrance at that end shall be closed by a door; (2) when the traffic passes through both tunnels 1,750 cubic feet of air per second will be forced into the northern end of No. I and the same quantity into the southern end of No. II, consequently the column of air in each tunnel will travel in the same direction as the trains. There will be doors at the northern end of tunnel I and the southern end of tunnel II. It is from reasons of economy that it has been decided to ventilate in the same direction that the trains travel. It may be seen, even in short tunnels, that the trains which pass through draw a considerable quantity of air after them; so that, by forcing air after the train at a greater speed than it would otherwise travel, the fan returns to the train the work done in pushing the air before it. This represents a saving in fuel which is the more marked in proportion as the speed of the trains increases.

The report then gives calculations to show that a pressure of 2¼ in. water is sufficient to force the required quantity of air through the tunnel, after taking the friction of the sides into account. It was shown that the power of the fans used during construction was much greater than this; so that they will be ample for ventilation after completion. There will be two fans and two turbines at each end, but it will only be necessary to use one. Even if the whole of the machinery at one end of the tunnel had to be stopped, the regular ventilation could be kept up from the other end. If, for example, the power house at the northern end only were in working order, one fan would force air into tunnel No. I while the other aspired it from No. II.

(17) Noxious Gas Produced by Locomotives Passing Through the Tunnel.—From a series of experiments, the company have found that, besides other gases, one pound of coal, when completely burned, produces twenty-six cubic feet of carbonic acid. On this figure they have based a series of calculations to ascertain the quantity produced by each train—express, ordinary or goods; and going from south to north or from north to south.

They then apply the results of these calculations to the different conditions under which the tunnels may be worked. First, when one tunnel only is open for traffic. Here they take as maximum a daily service of 4 express trains, 8 ordinary and 36 goods trains—or a total of 48, 24 each way. On this they find that the greatest excess of carbonic acid over that ordinarily contained in the atmosphere may amount to an average of 4 per mil in the southern half of the tunnel, and may reach 8 per mil near the south end. When both tunnels are being used, and each one ventilated in the direction in which the trains travel, the air will become more impure in tunnel II than in tunnel I. But under the supposition that a goods train enters this tunnel every thirty-five minutes, the excess of carbonic acid in the air, which will be at its worst near the northern end, will only be about 9 per mil. It is therefore safe to assume that never, under any circumstances or in any part of either tunnel, can it reach the limit of 1 per cent.

According to the Bauzeitung of September 3, 1893, there were 16,246 trains which passed through the Gothard Tunnel in 1892, and this makes an average of 44 trains per day, though the present time bill shows 57 per twenty-four hours. Considering the quantity of air in the tunnel, these trains will have regularly produced about 3 per cent. of carbonic acid. From a report by the chief engineer, Mr. Bechtle, published in the Bauzeitung of February 22, 1890, it appears that the whole mass of air in the tunnel remains motionless for twelve hours at a stretch, and that it puts itself in movement very slowly. During the period of immobility, it is quite possible that the excess of carbonic acid may amount to 1½ per cent.; and before the column of vitiated air had quitted the tunnel the proportion would probably have increased to 2 or 2½ per cent. Notwithstanding this, there have never been any serious complaints about the composition of the air in the Gothard Tunnel.

REPORT OF THE CONSULTING ENGINEERS NAMED BY THE SWISS FEDERAL COUNCIL.

Messrs. G. Colombo, Francis Fox and C. J. Wagner were requested by the Swiss government to examine the project for constructing the Simplon Tunnel, and to answer a set of twelve questions relating to the work. They were appointed on the 27th of last April, and furnished with copies of all plans, reports and documents relating to the work, including the contract dated September 20, 1893, between the management of the Jura-Simplon Railway and the contractors for the tunnel. They commenced their investigations by being present at the trials of the Brandt's rock drills and of the fans. These trials were made at the works of Messrs. Sulzer Brothers, at Winterthur, on the 4th of June, and at their conclusion the experts visited the site of the proposed tunnel.

The engineers' report is divided into four sections—construction, ventilation, working after completion and miscellaneous. The following are the questions they were asked to answer, together with a summary of their replies:

I. Construction.—(1) Are the machinery and appliances described in the company's report sufficient, and will there be adequate hydraulic power at their disposal?

Both are amply sufficient. It will always be easy to obtain the requisite amount of power, both for construction and working, on account of the large number of rivers and streams in the vicinity, some of which yield large quantities of water. Besides this, the low altitude of the ends of the tunnel allows for very considerable falls. If at any future time further power should be required, the existing water supply can be used with a higher fall. Besides this, there are at both ends sources which, according to the present project, it is not proposed to utilize. On the north side, allowing for an effective force of 75 per cent., we have: The Massa, minimum 93 gallons per second, with 1,640 ft. available head = 2,100 horse power; the Saltine, minimum 110 gallons per second, with 164 ft. available head = 250 horse power; and the Ganter, minimum 35 gallons per second, with 1,640 ft. available head = 800 horse power. On the south side the Cairasca, with a minimum of 132 gallons per second and an available fall of 656 ft., can at 75 per cent. produce 1,200 horse power. In the project it is only proposed to utilize 300 horse power of this, so that there remains a reserve of 900 horse power on the south. Moreover, there will be the steam engines in reserve, capable of furnishing 180 horse power on the north and 225 horse power on the south. For the Arlberg Tunnel they only had one steam engine at Langen; it was of 80 horse power, but could be worked up to 100 horse power. We also wish to call attention to the following points: On the north side we can only agree with the project for bringing water under pressure to the tunnel by the borehole at Berisal, under the condition that the water shall be conveyed down this hole in a pipe which is capable of withstanding pressure. Considering the high pressure of this water, this precaution seems necessary, both for the useful effect of the work and for safety during construction; as well as for the preservation of the masonry near the lower end of the bore hole.

As it is to be presumed that the bore hole will bring with it into the tunnel water which it will meet in the interior, we recommend that it should not be driven exactly over the tunnel, nor over the parallel heading—tunnel II—but on one side. During the second period it is desirable that the daily progress should be greater than that estimated in the scheme of work attached to the contract, so that the contractors may not be obliged to press on the work in the headings too much toward the end. According to the observations we were able to make when visiting the site of the two ends of the tunnel, it would seem difficult to find sand suitable for building. It would therefore be well to consider at once as to the advisability of putting up stone breakers, so as to make sand with good gneiss. The experts approve of the sanitary arrangements which have been made, but consider that all workmen should be medically examined, both before being engaged and at regular intervals. They also recommend very minute inspection of the workmen's dwellings, beds and food.

(2) Is the cross section of a single line tunnel to the dimensions given a suitable one, or should it be changed, either on account of the requirements of ventilation or in view of the possibility of repairs having to be carried out in the interior of the tunnel?

The cross section is of suitable dimensions, taking both ventilation and repairs into consideration. The headway shown in the designs is sufficient for the purpose of ventilation, by methods which will be discussed further on. With regard to the second question, taking into consideration the clauses of the contract which refer to good workmanship in the tunnel masonry and the long period for which the contractors have to guarantee their work, nothing is likely to happen which can damage the masonry in the future, unless, perhaps, it should be caused by the composition of the water that may filter through the soil. But, even if this should occur, there will be sufficient free space to allow for rebuilding. By using iron centering there will remain headway enough for the trains, and rebuilding could be carried on inside the tunnel by lessening the traffic.

In the long tunnels, which have till now been made for two lines of rails, it has always been necessary to consider the possibility of one of these lines being rendered useless. This would cause a much more serious disturbance of the traffic than having to limit it in a single line tunnel. If anything should happen rendering it necessary to reduce the sectional area to such an extent that reconstruction from the interior became difficult, this work can be done from outside the periphery, as practical examples have proved. Bench marks should be placed along the walls to fix the position of the center of the track with regard to the side of the tunnel, and the position of the principal points should be measured periodically.

(3) Is the distance of 56 ft. between the center lines of the two parallel tunnels sufficient?

The distance of 56 ft. is sufficient; because, as it may be seen by the geological strata on the longitudinal section, the beds of rock usually run in a direction which is almost at right angles to the axis of the tunnel. For this reason, the two excavations can have no prejudicial effect on one another, even if the rocks which are being traversed are placed unfavorably, provided that necessary precautions are taken when the headings are opened out.

(4) Can all the arrangements made for the progress of the work, such as position of working faces, machine drilling, progress of headings, transports, etc., be accepted without modification?

The proposed procedure can be adopted almost without modification. In a tunnel of such considerable length, hydraulic transmission is always to be preferred to any other system, because the loss of power is less with this than with other systems, and because by its means sufficient force can be transmitted to drive the rock drills at full speed through Antigorio gneiss, which is the hardest rock in the Simplon. Brandt's system of rotary perforation with hydraulic transmission is in this case considered preferable to any other system. The experiments made at Winterthur with the newest type of Brandt rock drill on Antigorio gneiss showed that the rate of progress on which the contractors reckon was realizable. A hole 2¾ in. diameter was drilled to a depth of 40 in. in twelve to twenty-five minutes; and this is equivalent to 2½ hours per attack, and an average progress of 19 ft. 3 in. per day. On account of the favorable position of the geological strata with regard to the axis of the tunnel, there is no doubt about being able to work the rock drills in the headings without difficulty. It will only be in quite exceptional cases that it may be necessary to timber the advance headings immediately. With regard to the arrangement and distance apart of the working faces, we recommend that the work should be arranged according to the English system; but with this modification, that wherever timbering should become necessary, it should be done by means of isolated trusses, i. e., independent of the masonry which has just been constructed. We do not think that it would be advisable to apply partially the Belgian system for the excavation, and for building the masonry, because there would be no advantage in doing so; and working on two different systems at once would be liable to cause confusion. To facilitate as much as possible both ventilation and carriage, the length of the upper headings and their distance apart should be reduced as much as possible from the end of the second mile. With regard to the movement of trains in heading II, it would be advisable to make one change. When the locomotives employed for haulage enter by this heading, which also serves for ventilation, they should come in with sufficient boiler pressure to take them out again without having to make up the fire while they are in the tunnel. But when the heading is about five miles long and the round journey consequently ten miles, this will be impossible. It will therefore be necessary to keep open a connection between the track in the heading and that in the finished part of tunnel No. I, at the distance which experience shows to be requisite. The engine can then be shunted through into the finished part of the tunnel and there get up steam; after which it can be shunted back into the heading to continue its work. This will prevent the air intended for the ventilation of the workings from being vitiated by the gas from the locomotives, and this we consider to be very important.

(5) Can the estimates of expenditure be considered as sufficient?

The different sums set down in the estimate may, taken together, be considered as sufficient. For outside work at northern and southern ends, £280,000 has been allowed. At the Arlberg Tunnel, which is six miles 640 yards long, the cost of outside work, including all buildings, water conduits and machinery, was £150,577. At Arlberg, everything connected with transport, sanitary arrangements or electric lighting, was the property of the contractors, and the cost of these appliances had to be included in the prices paid for different classes of work in the tunnel. By clause 3 of the Simplon contract, it is stipulated that all these shall become the property of the railway company, so they have to be included with the fixtures. Taking the actual expenditure at Arlberg as a basis, the extra expenditure for rolling stock at Simplon may be estimated as: Six locomotives at £470 each, £2,820; two running sheds at £140 each, £280; 160 trucks at £25 each, £4,000; total, £7,100. The length of track in the tunnel and in gallery No. II will be about 43,750 yards. To this must be added 2,200 yards for one hundred passing places, 10,940 yards for approaches and lines to power houses, etc., and 550 yards for various branches; a total of 57,440 yards. Supposing that 26 lb. rails are used, as at Arlberg, this will cost, at 10s. per yard run, £28,720. Add 100 points and crossings at £44 each, £4,400; and £88 for eight turntables at £11, giving a total of £33,208. The expenditure for baths, hospital, restaurant, etc., at Arlberg was £1,364. Supposing that double this outlay will be required at each end of the Simplon Tunnel, we have £5,456. For the electric lighting and telephones we have assumed a round sum of £5,200; and we estimate for sundry expenditure—dynamite stores and heating apparatus, £1,080; six cranes for loading stone, £988; stone breakers and mortar mills, £700; spare drilling machines and all necessary duplicates, as well as tools, both in use and in reserve, £6,218; total, £8,986. These various items added to

gether come in round figures to £60,000. Add this to the Arlberg expenditure of £150,577, and we have £210,577. According to these calculations, there would remain a sum of less than £70,000 for the increased size of the power works at Simplon, for the extra expenditure on the water conduits, for the cooling apparatus in the tunnel, and for other unforeseen outlays. This seems to us so small that we are justified in believing that the expenditure of £60,000, which the contractors will have to incur, is not included in the £280,000. But this will cause no increase in the total cost; because, as we shall see, the prices for excavation have been proportionately increased.

In examining the schedule of prices on which the monthly payments will be based, we find that for the headings the prices are, on an average, those usually paid at present. For finishing the excavation and making the channel for draining the first tunnel, we find that the average cost of a cubic yard of excavation is 21s. This is assuming that the different sections of masonry for lining the tunnel, as shown on Fig. 3, will be used in the proportion computed by the contractors in the estimate which they have based on the longitudinal geological section, excepting that we have everywhere assumed that type 2 will be substituted for type 1. This average price is too high, because it includes the greater part of the constructions which have already been valued at £60,000. To be accurate, this sum should be added to the cost of outside work and deducted from the charges for excavation. But in order to avoid any alteration in the contract prices, we consider that they may be accepted as they stand, it being understood that the expenditure which this £60,000 is to cover is included in the series of prices for work done inside the tunnel. In considering the masonry work, we have taken type 2 as the minimum section.

This was stated above when referring to excavation. It will only be during construction that it will be possible to find out whether type 1 can be used anywhere. We find that the average price is 24s. 6d. per cubic yard for the masonry in the sides and 36s. 9d. for that in the arches. As the contractors may possibly be obliged to use in some places heavier sections than they now contemplate, these prices seem to be low; but taking local conditions into account (easy quarrying on the Italian side), they may be considered as sufficient. The other prices in the schedule seem to us to be satisfactory. The augmentation in the prices as the work advances toward the center of the tunnel seems to be well arranged. In the first three miles from either end, the price of the finished tunnel has been kept as low as possible, to allow of higher prices in the other six miles. This will prevent any financial deception, even if extraordinary difficulties should be encountered toward the center. It is stated in the contract that in each of the tunnels four large rooms, spaced three miles apart, are to be substituted for four of the small ones. But with this spacing there can only be three large rooms. However, as a special place will be required in the middle of the tunnel for electrical apparatus, etc., we propose that two rooms should be made there instead of one.

NEW MACHINE FOR DECORTICATING RAMIE.

RAMIE, as well known, is a plant belonging to the nettle family (Urticaceæ), and indigenous to warm and humid intertropical regions, where it yields as many as five or six crops a year. Its stalk furnishes a fiber which, as regards strength and aspect, is intermediate between flax and silk. Unfortunately, it is impossible to extract but from 4 to 10 per cent. of harl from it at a maximum, the 96 or 90 per cent. residua being composed of wood, pith, cuticle, gum and water. Moreover, it is impossible to ret this plant, since the fermentation of the stalks destroys the textile fibers themselves.

To free these fibers from the large quantity of useless material that invests them is the delicate problem that nature lays before the manufacturer and cultivator. It was long ago solved by the patient Chinese, who takes the stalk, detaches by hand the pellicle that surrounds the wood and contains the fibers, and then hackles the cuticle with a bamboo knife and gradually frees the fibers that are agglutinated with the cuticle or the gum that the plant contains. Accurate data as to the cost of this manipulation to which the Chinese cultivator devotes his spare hours are wanting, but it may be estimated at a few cents an hour. Nowhere else except in China is it possible to find manual labor at so low a figure, and that is why the cultivation of ramie is limited to certain parts of the empire, which are not those most favorable to the culture, but those in which hand labor is at the lowest price.

In Madagascar and Java the plant grows in a wild state and is not even gathered, owing to the want of hands to decorticate it. For several years past, however, a certain number of machines have been studied and constructed with which the ramie may be easily decorticated so as to obtain from it strips free from wood and pith, but still containing cuticle and gum in such abundance as to render the bleaching of it most difficult. It became necessary to imitate as closely as possible the Chinese hand labor, and to obtain a true hackling of the cuticle by means of a machine which, while accomplishing this delicate work, should give a good industrial rendering. This is what Mr. Estienne seems to us to have succeeded in accomplishing with a new machine that has decorticated and freed from wood, in our presence, ramie stalks from various sources, removing not only the wood, but also the cuticle and furnishing a harl in a state of division sensibly even more advanced than that of the China grass decorticated by hand by the celestials.

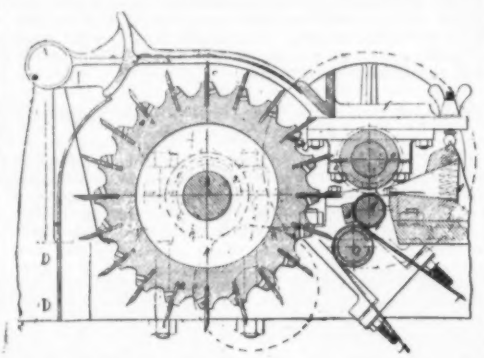


FIG. 1.—NEW MACHINE FOR DECORTICATING RAMIE—DETAILS OF THE PRINCIPAL PARTS.

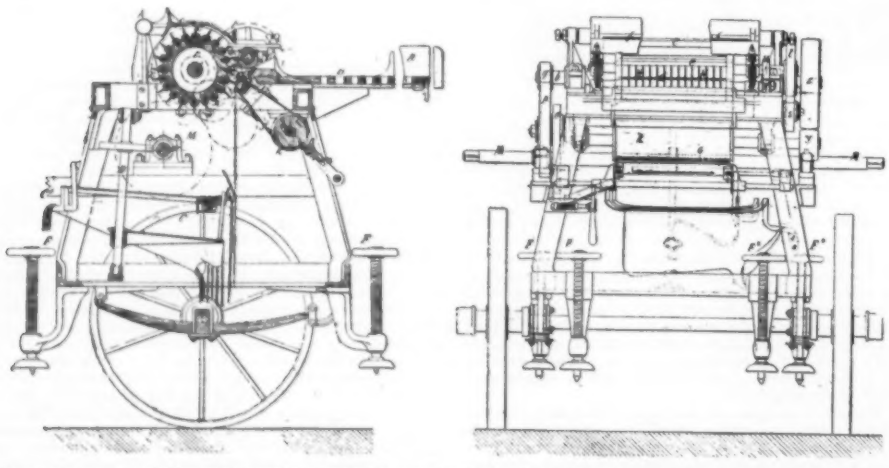
Fig. 1 represents the principal parts of this machine and will permit us to explain the operation of it.

A cast iron scutcher, a, mounted upon an axis, b, and provided with steel blades, c, breaks upon a steel block, h, the ramie stocks that are fed to it by two distributing rollers, e and d, the first of which is covered with rubber and the second of which is of steel and is toothed. The same blades, c, of the scutcher afterward seize the stalks and compress them between their extremity and an endless belt, j, which is itself carried by a steel roller, i, covered with rubber. As the blades of the scutcher and the endless belt, which have the same tangential velocity at the point of contact, possess together a velocity eleven times greater than that communicated to the stalks by the distributing rollers, there results an energetic, but elastic, hackling perfectly imitating hand work.

The cylinders, e and d, have the same tangential velocity at the point of passage of the stacks, which they firmly hold, since at this point the wood has not been broken. From the blades and the endless belt having the same tangential velocity at the point of contact, it results further that there is no sensible wear of the belt by the blades and that the action occurs only upon the stalks freed from wood.

The distributing rollers are preceded by an open work table, BB_1 (Figs. 2 and 3) terminating in a series of receptacles, H, formed of flat springs, and into which the workman who does the feeding thrusts the extremity of the stalks. A collector, C, of special form takes from under the table the decorticated harl and presents it at C to the hand of the workman, whose business it is to gather it.

In the trials that have been made the machine has decorticated 22 pounds of stalks per minute, which would correspond to about 6 tons for a period of ten hours, and would furnish, according to the quantity of ramie, from 530 to 1,320 pounds of dry harl.



FIGS. 2 AND 3.—NEW MACHINE FOR DECORTICATING RAMIE—VERTICAL SECTIONS.

If we now pass to an examination of the details of operation of the machine, we shall see in the first place that the distributing cylinder, e, can, with its bearings, oscillate around an axis, A, with which it is connected by the cheeks, f, and this permits of opening the machine by detaching the springs, g, and of inspecting and cleaning it.

The collector, C, consists of a trough formed of two iron plates which are designed to receive the fibers and between which moves a metallic finger, E, revolving around a vertical axis, D.

F, F_1, F_2 and F_3 are leveling screws serving to fix the machine upon the ground during the work. A strong cast iron frame (Figs. 2 and 3) supports all the mechanical parts. It rests upon the axle of a pair of wheels through the intermedium of springs.

At M is the axis of the winches, four men working upon which can easily furnish the motive power necessary to run the machine.

The transmissions of motion are all obtained by means of gearings (o, p, q, r, s, t, u, v), with the exception of the drum, K, carrying the endless belt, which is actuated by means of a belt mounted upon pulleys, x and y.

At G there is placed a brush for cleaning the endless belt.

The metallic block, h (Fig. 1), is supported by the pillow blocks of the roller, d. Owing to this arrangement, this piece, which is submitted to violent shocks, can, in case of damage, be easily changed. In order to permit it to resist the shocks that it undergoes during the work, it is provided at each extremity with a bolt by means of which a tension may be exerted between the pillow blocks. This artifice considerably increases the resistance of this piece to flexion.—Le Genie Civil.

SLATE ENAMELING.

By G. B. BENFORD.

THE art of enameling as applied to metals is as old as history itself, but, perhaps, no countries have carried it to such a state of perfection as have the Japanese and Chinese.

With them to this day it is, in many respects, jealously guarded among many of them as family secrets, almost all of them having some peculiar methods of mixing or burnishing their respective enamels or, as they call them, lacquers. We are familiar with their work in this country, in the shape of fan handles, tables and beautiful cabinets. But it is not the Japanese art that I wish to explain, but only enameling as applied to slate as we know it today. Whether the marbleizing of slate was first done in this country or in England I cannot say, but almost the first public notice of any account that I have come across is that published in "The Crystal Palace and Its Contents," an account of the great exhibition of 1851 held in London, Eng. I will here state what they had to say in their column headed, "Magnus' Work in Enameled Slate." "Among the numerous interesting mineral manufactures in the British department of the great exhibition there were few, perhaps, which attracted more general attention than the various elegant articles in enameled slate.

"Foreign visitors especially appeared struck with surprise to find representations of their most costly marbles so perfectly faithful to nature as to be with difficulty distinguished from marble itself; and even with a placard attached to the articles, stating that they were of slate, it was difficult for some of the visitors to believe the fact. On the ground of novelty, enameled slate stands unrivaled, for, until the last few years, the uses of slate were limited to the roughest purposes. An occasional piece had indeed been smoothed, painted and varnished in the style of tea trays, and ornamented with a flower or bird in the Birmingham fashion, but it remained for Mr. Magnus to display its full capabilities and to adapt it to its present varied purposes, superseding in a great measure the use of foreign marbles, and thus opening up a wide field of employment for native artists. Among the articles displayed was a portion of a bath room, in which representations of porphyry, lapis lazuli, giallo antico and other marbles and rare stones were introduced with a pleasing and artistic effect. A column and vase of porphyry—a splendid billiard table, the legs and frame of which, as well as the bed, are of slate; several inlaid table tops, chimneypieces, candelabra, etc.—served to show the many purposes to which this useful, novel and interesting invention is applicable."

The above extract will show to what extent the enameling of slate had gone to deserve special mention as an exhibit in those days. In those days the system was to a great extent a secret known only to the few, and the dipping room was as sacred as the "sanctum sanctorum" of the editor, some men even going so far as to do all their dipping at night when the rest of the men had gone home, reminding one of the old alchemists in the middle ages. But those days are gone. Everybody now pretends to know how to do it.

The uses to which slate, in its marbleized form, can be put are many and varied, such as mantelpieces, wainscoting, church altars, clock cases, columns, urns, scale boxes, table tops, etc.—these are but a few. I will endeavor to explain, to those who may not know the process, the way, as the conjurer says, it is done.

The slate having been received from the mills, cut to size and rubbed smooth, it is now ready for the "cutters." The "cutters," as the name implies in a finishing shop, are the men who carve, trace and fit the slate into marketable form as a finished product prior to marbleizing. It is the province of the cutter to see that all his lines are cut fine and true, his mouldings perfect, with clear, well defined miters and his work perfectly squared. The next step is the sand rubbing; this part of the work many employers that I have noticed consider to be unimportant and that the cheapest of help will do for it. I myself think this to be one of the most important, if good work be the end in view. A poor man can with a piece of grit spoil more work in five minutes than a cutter can rectify in two hours. The work of the sand rubber is to reduce all level surface to a smooth uniform face and at the same time leave the tracery intact. His work should be free from scratches, but rather of a fine granular appearance like ground glass; the better the sand rubbing, the easier the rest of the work. If there is one thing that will make the work look bad, it is that one thing, coarse sand rubbing.

After the work has been wiped dry and free from sand it is passed to the paint room.

The multiplicity of marbles and rare woods imitated demand quite a range of colors for the ground work. Many of these colors are dipped, others hand grained and others hand marbled with sponges and feathers.

We will suppose that the work we are going to see through the shop—from an imaginary point of view—is to be dipped work.

The painter takes his work and goes over it care-

fully, looking for any defects that have to be puttied or stopped; he then paints it—we will say in this case—black; it is then carried into the kiln or oven.

This kiln is a room about 10 or 12 feet square and 7 or 8 feet high, built generally of brick between the studding, and over all sheet tin is put, covering the walls and ceiling; the floor, brick or slate. This room is fitted with racks to hold the slate in a horizontal position; a good size kiln will hold from sixty to one hundred mantels. The heat is generated, in most cases, from a large mill stove and the temperature required from 150 to 350 degrees. The work is allowed to stop in over night.

The next day after the paint work has been baked it is ready for the dipping room; to facilitate the work all the different colors are stood in separate lots in the dipper's room; it is usual to dip all the plain colors first, by plain colors I mean those of only one or two veins and plain black float; the reason of this is, if colors demanding a red, green or white float be dipped the first, then those colors with black ground, if dipped the last, would be apt to get a portion of those too pronounced floats on their face, which would make them look cloudy and far from a clean job.

The tub in size may be anywhere from 8 to 12 feet long, from 4 to 6 feet wide and about 2 feet deep, made of pine plank 2 or 3 inches thick, sometimes cased with zinc on the inside. This tub is filled with water to within two inches of the top.

The tools needed for the work on the tub (if tools they can be called) are very simple, three or four pieces of stick long enough to reach across the tub, the ends of which are slotted. These pieces are about six inches wide and are just cut out enough on the ends to allow them to go down under the surface of the water about an inch, forming in reality movable ends; these are moved about at the marbleizer's discretion to form his work. The first thing in putting on a tub (the technical expression for preparing the colors on the tub) is the float, the principal thing in the float, be it black, red, green, white or any other shade, is damar varnish; this forms a body. The marbleizer by a quick, dextrous movement throws on with a stick sufficient of the float, when it spreads, to cover the tub, but at the same time forming a well defined and clouded appearance. If there be too much gum damar in the float, it is known by the float being heavy, acting sluggish and forming a skin too rapidly upon the water; this is corrected by the addition of a little marble oil or turpentine; the objects of the float are in most colors two, with many colors the float forms part of the cloudy work seen in the marble, and the other and more important is in holding the veins in their places; a good, clean and free vein partaking of the characteristics of the marble sought to be imitated is what is needed; the reason that the veins retain their individuality is found in the fact that the float and veins are composed of vehicles in the color of a different density, as for example if oil, water and molasses be poured into a glass jar, although all three be in a liquid state, yet they will not readily mix, but will show a clearly defined line of demarkation.

The veining color when thrown upon the tub in streaks is broken up and moved to and fro by the marbleizer until it assumes the desired effect; having the tub all ready to dip in, the marbleizer takes up a piece and with the painted side away from him he gently dips it at a slightly oblique angle, pushing it a little from him, by so doing you get a tighter vein than if dipped just flat on the water. When taken out of the water, if there be any panels that have to be of a different color these must be wiped out, usually done with a piece of sponge soaked in kerosene; this now goes into the kiln to be baked through the night. In the morning when removed from the kiln it is carried to the varnish room to be varnished for scouring. The varnish should be of the best suited for the work, should be hard, yet elastic enough, so that when baked it should be free from those fine cracks seen often in varnish made too hard. Before the scouring varnish is put on many prefer to put in their panel work, that is the different colors that go in the places that were wiped off the day before, while others prefer to put it on after the scouring. After the varnish is baked it goes to the scouring banker; here the men are supplied with lump pumice stone and other grades of pumice powder, and sponges, chamois leathers and blocks covered with felt.

The scourer begins by first rubbing his work over with a cake of dry soap, the advantage of this becomes soon apparent, it keeps his pumice stone from dragging or sticking to the work. When he has soaped his work he throws on some pumice powder and a little water, then goes over the whole with the lump pumice, which has a good surface free from grit or flint; having, as he calls it, stoned it down, he then takes the felt block and a little more pumice powder and gets a still smoother surface. He must be careful and not erase any of the work or, as they say, cut it to pieces. If by mishap he does so, he must touch it up or send it back to the dipping room. After being scoured, and before the flowing or last coat of varnish is put on, all black work, such as bands or panels, or all work not heretofore put in in colors, must be done.

It used to be the practice to put the work into the kiln for an extra baking preparatory to the last coat of varnish, to dry or sweat out the scouring coat, but the great improvement in varnish has rendered that almost unnecessary. After being flowed—here the varnisher must be as clean about his work as possible, for the cleaner the flow, the easier the rubbing and polishing—I will reiterate—after being flowed it is again baked; it then comes out for rubbing and polishing. All work that has got to be gilded is stood near the gilding banker by itself. The gilding is done with gold leaf bronze mixe d with a prepared liquid and painted in the lines with a small brush. As long as the lines are gilded solid it does not matter if some gets out on the face, as that will get rubbed off when the rubber takes it in hand, and, of course, the gold in the lines being below the surface of the slate the block does not touch that, so that it remains. The rubbing is done with a felt covered block, the material being F. F. F. grade of pumice powder. The rubber must be careful of his edges and mouldings so as not to rub too long or too heavy in one place, or when it gets to the polisher it gets stood back with just two words: "cut through"—this means the polishing coat of varnish has been rubbed off and will not finish well, and must therefore go back to be revarnished. When rubbed it is passed to the polisher, who with felt blocks and rotten stone still gets a smoother surface. Here the varnish begins to assume a brighter appearance. It is at last finished off with the palms of the hand alone, and it may be here remarked that the hand has to be pretty free from scars or rough places, or the boss might come along and picking up a polished piece hold it at an angle where the light would strike it, and just say "hand scratches"—that means either your hands are not in condition or you have been careless in freeing them from grit. After being polished they go to the packing room, where they are put together with angle irons and screws, and packed with straw into boxes.

I have in this article just treated of mantels, but almost precisely the same course is taken with all other classes of work, the colors and uses of which are many and numerous.—Stone.

A NEW EXTRACTING APPARATUS.

THERE are few industries at the present day which have not, within the last fifty years or so, undergone more or less complete revolution.

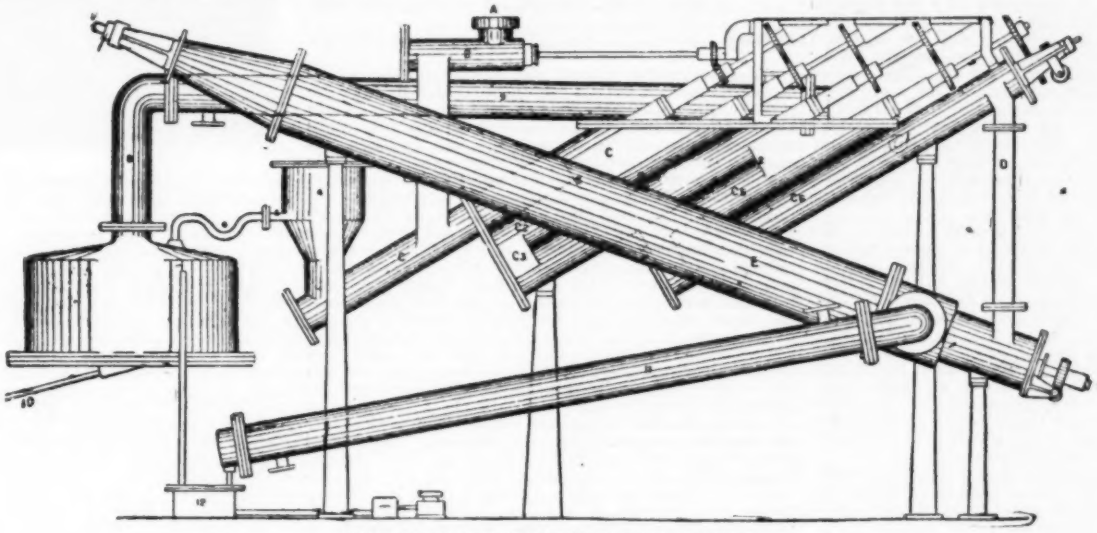
But, though the progress in methods of manufacture has been vast and rapid, there are still a few industries which have changed but little, and the oil industry is one of them. If we consider the great improvements that have been effected by chemistry in most industries, it seems strange that oil should still have to be separated from seeds, etc., by the comparatively crude method of mechanical expression. Despite the perfection to which this method has been carried, chemical extraction has a great advantage over mechanical in regard to the yield. In the case of porous materials especially (such as cottonseed), this would often mean a double yield of oil with much less labor, and hence less cost.

Before describing the latest attempt in this direction, it will be as well to briefly consider the nature of these conditions and the chief difficulties that had to be encountered.

The most important step is recovering the ether or other solvent from the waste product in the macerator. These macerators must necessarily be a considerable size, and when extraction has been completed, there is left behind a large bulk of starch and husks (in the case of seeds) saturated with solvent, which must be distilled off before the macerators can be emptied, and here lies the chief difficulty. The material left in the macerator is a bad conductor of heat, and therefore it is very difficult to heat the mass sufficiently to insure complete volatilization. To this a second difficulty is added by the fact that the volatilization of the solvent is attended by a great depression of temperature in those parts which are not readily reached by the heat of the steam. The writer, who has had considerable experience with this kind of apparatus, found on one occasion such a charge completely dry and hot at the sides while the center was a frozen mass. But further, when the solvent has to be driven off by live steam the material gets "cooked," and when taken out is in a moist state, which in many cases is detrimental.

The apparatus described below has been designed with a view to overcoming all these defects. Instead of passing the solvent through a large mass of material, the material to be extracted is passed through the solvent, the latter flowing, at the same time, in a contrary direction. How this is effected will be best understood by a reference to the accompanying illustration: C, C_2, C_4, C_6 and C_8 are cylinders alternately communicating with each other at top and bottom, in which spiral conveyers work. The material is fed in at A (which when not at work is hermetically closed by a water seal), forwarded by a screw working in B, and falls down the vertical shoot into C. There it is carried upward by a screw to C, where the first cylinder communicates with the second, falls on to the screw working in C_2, is carried downward, and falls through the communicating channel C_3 on to the next screw. This again forwards the material in an upward direction, in turn being carried downward in C_4, and up again in C_6, in the upper part of which there is a squeezing arrangement to express the excess of solvent, after which the material falls through D into the kiln E provided with a steam jacket and forwarding screw, in which the exhausted material is deprived of the residual solvent. This is here easily effected, as the material is spread out in a thin layer over a large heated area. The vapors, which are considerably heavier than the air, and hence have a downward tendency, are allowed to escape at the lower end of the kiln, and are condensed in their passage through 11, collected in receiver 12, and pumped back into the machine at 1.

While the material thus travels from left to right, the solvent flows in an opposite direction, whereby the partially extracted meal, etc., meets in each successive cell with a purer stream of solvent, thus insuring nearly complete exhaustion. On the other hand, the solvent comes successively in contact with material richer in oil, finally passing into the first cell (the last as regards the direction of the solvent), where it meets with the largest quantity of oil, passes through a filter 4, and thence into retort 7. This latter part of the apparatus is provided with several trays, each steam jacketed, over which the mixture of oil and solvent flows in a thin stream; the solvent being volatilized and condensed, while the oil flows out in a continuous stream at 10.



IMPROVED EXTRACTING APPARATUS.

The whole process is continuous and automatic, and the plant requires very little attention. A man and a boy can manage four plants.

One very important feature in connection with this apparatus is that the material, after the extraction of the oil, can be stored for any length of time, as the material is not in any part of the process subjected to the action of steam, the drying being effected in steam heated pans. Many materials when subjected to the action of steam give up or lose to some extent their manurial properties.

The apparatus has been worked successfully with various seeds and waste products. In the case of fish, a guano has been produced containing 13 per cent. of ammonia, the usual percentage in this material being about 10 per cent. The guano is turned out practically free from oil, and in a clean, dry condition.

The apparatus, which has been patented in this and most foreign countries, can be seen in operation at the works of Messrs. Cole, Marchent & Morley, of Bradford, Yorkshire. The inventors are Messrs. Dombrain & Trumper.—Chemical Trade Journal.

ELECTRIC LIGHTING FOR CARRIAGES.

IN a recent report to the State Department, C. W. Chancellor, the United States consul at Havre, France, makes some pertinent remarks concerning the lighting of carriages by electricity. He says:

"Gas lighting, which was common in London as early as 1810, was not introduced into Paris until 1819, and more than twenty years elapsed before its use as an illuminant became general in France. On the other hand, when we turn to the subject of electric lighting, it must be admitted that France has taken a foremost rank among European nations in adopting the electric light.

"In Paris, electrically lit private carriages have, for the last five years, been extensively patronized by the affluent classes, but only recently has this process of lighting been applied to private carriages in London and Berlin. The Prince of Wales was the first to adopt it in London, and now we learn that the German Emperor has brought the resources of his active mind to bear on the subject of lighting carriages, and,

as a consequence, the court carriages in Berlin are now lit by electricity, not only by outside lanterns, but also in the interior, which is illuminated by a series of accumulators carried in the vehicles. All over the harness are placed what the Germans call Gluhlampen, or small colored lights, which glow like fireflies when the carriage is in motion."

It is obvious that the adoption, on an extended scale, of electricity as an illuminating agent in private and public vehicles would serve a double purpose—first, one of a distinctly practical usefulness; next, that of increasing the brightness and cheerfulness of the streets, which would materially aid in the beautifying of a city. Again, it has been ascertained that the more the omnibus and street car companies make their vehicles attractive, the greater will be their traffic.

In private carriages, the electric lamp is placed inside in the center of the roof, and the flat twin lamps are shielded by a circular glass plate rather larger than the "bull's eye" of an ordinary searchlight. At the back of the lamp there is a dome or bell-shaped enameled reflector. In order to economize space, the flat lamps are not hung vertically in the bell protector, but lie horizontally, and in order to prevent the filament from drooping when hot, a little glass anchor is added to support them. In this way, the roof of a brougham is fitted with a light diffuser which will not interfere with a person's head entering the vehicle. Each of these lamps gives a light equal to seven candles.

In the first attempt to light carriages in this manner the moving of the carriage was apt to jar the lamps, often causing a breakdown, and steel springs were not found sufficient to prevent this. The plan now adopted is to suspend the complete lamp in a sheet of rubber, which is attached to the interior of the carriage, neutralizing the vibration. It is only necessary to press a button in order to switch the current on, and by a second push it is turned off again.

A sufficient supply of electricity required for the lamp is stored in an accumulator. One accumulator, weighing two pounds, is the allowance for each lamp. Should the two outside lamps be also electric, two additional batteries would be needed. The accumulators are carried in the boot, under the coachman's seat, and are easily accessible. The coachman himself, without electrical knowledge, makes the necessary connections.

An eight-cell storage battery for an ordinary family carriage or brougham is contained in a box 8 inches long, 4 inches wide, and 7 inches deep. This supplies the current to keep the lamp lighted for eighteen hours, which ordinarily is sufficient to last the owner of the carriage from one to two months. The cost of recharging varies from 50 cents to $1—not more than the expense entailed by the employment of oil lamps, which invariably give out an unpleasant odor and an uncertain illumination. The electric lamp does not wear out unless subjected to careless treatment, or unless it is weakened by the application of too strong a current. The accumulator, however, makes the latter contingency almost an impossibility.

There appears to be a fair prospect that, in the course of a few years, the majority of public conveyances in cities, as well as private vehicles, will be lighted by electricity; but the public will, of course, expect that electric lighting shall be superior to oil. This question seems to have been already quite well determined. It has been found that an electric lamp of 2½ candle power will enable any passenger to read in comfort while traveling. Apart from the actual amount of light to be afforded, which, of course, is capable of adjustment, it may be stated that the latest form of battery overcomes the difficulties which have hitherto stood in the way of the adoption of electricity for the lighting of street conveyances.

A street car battery, working two lights to illuminate the interior as well as the colored signal lamps, will weigh about 30 pounds, and furnish a light, equal to 2½ candle power, for from forty-five to fifty hours.

Lamps applied to omnibuses, street cars, and cabs differ in form. The omnibus light is fixed in a globe, smaller and flatter than the pattern which screws the oil lamps in a European railway carriage. Behind the lamp is a concave reflector of enameled iron. There is no restriction as to the form of the street car lamp, as the same conditions do not apply; but in the cab lamp, where economy of space is a consideration, the globe, contained in a semicircular reflector, having a glass front, is placed upright at the back of the vehicle over the passengers' heads. The cost of such installation, including the accumulator, is about $50.

[FROM THE ELECTRICAL WORLD.]

DOES EXECUTION BY ELECTRICITY, AS PRACTICED IN NEW YORK STATE, PRODUCE INSTANTANEOUS, PAINLESS AND ABSOLUTE DEATH?

OBSERVATIONS MADE AT THE EXECUTION OF DAVID HAMPTON, AT SING SING, JANUARY 28, 1895.

By A. E. KENNELLY and AUGUSTIN H. GOELET, M.D.

SOME observations by D'Arsonval, of Paris, having led him to the unwarranted conclusion that in electrical executions as practiced in New York State the death of the criminal was not produced by the passage of the current, but by the knife of the surgeon during the subsequent autopsy, considerable discussion has lately arisen as to the correctness of D'Arsonval's opinion.

On the 28th of last November the Electrical World, in the desire to definitely settle this question, directed a letter to Governor Flower, of New York State, requesting that at the next electrical execution scientific witnesses should be selected whose duty should be to make such observations as would throw light upon the matter. This recommendation was favorably received, and the writers were appointed to perform this very unpleasant duty on the occasion of the twenty-fourth electrical execution in New York State.

The following observations were made:

An alternating current was used in the execution, which was supplied from an alternator having a frequency of approximately 102·3 cycles, or 204·6 alternations or reversals per second, with an armature specially wound for a maximum E. M. F. of 2,500 volts effective. The field excitation of this alternator was controlled by means of a rheostat inserted in the exciter circuit and situated in the execution chamber.

The electrodes consisted of flexible brass gauze sheets firmly attached to sponges which were saturated with an aqueous solution of common salt. The upper electrode was fitted into a cap, shaped to conform with the top of the criminal's head, and provided with a chin strap which held it firmly in position. The lower electrode consisted of a similar flexible brass gauze plate about 8″ x 3″ and its moistened sponge, attached by a strap to the calf of the right leg. The criminal was placed in a sitting position in a stout chair to which he was confined by straps. The criminal was a negro, short, but young and of robust physique.

Preparatory to the execution, in order to test the circuit, a bank of 20 incandescent lamps in series was placed in circuit in the chair, when a pressure of 1,740 volts effective was observed on both Weston and Cardew voltmeters, and this pressure was then maintained.

The following are the detailed observations made:

11:18:45. Criminal entered room.
11:18:50. Seated in chair. Straps applied.
11:19:58 Electrodes adjusted and connections made with same.
11:20:13. Current applied at pressure of 1,740 volts. Ammeter nearly dead beat, indicating approximately 8 amperes steady through body of criminal.
11:20:17. Pressure intentionally slowly reduced, and current falling slowly to 1·8 amperes.
11:20:42. Pressure intentionally increased to a maximum not observed, the current increasing to 4 amperes.
11:20:50. Pressure again reduced to about 150 volts, the current falling to 1·3 amperes.
11:21:10. Circuit broken, current off. Period of application 57 seconds in all.
11:21:20. Chest was examined and no action of the heart could be detected. At this time a marked hyperæmia or redness of the skin covering the chest, especially the upper part, was observed. This paled on pressure, the color returning slowly. There was marked pallor of the face, slight froth in the mouth, and pupils of the eyes were dilated.
11:25:00. The criminal was officially pronounced dead.

The moment the current was turned on, the whole body was thrown into a condition of intense tetanic rigidity, the hands were contracted or closed tightly and the extremities straightened as much as the straps would permit. While the current was on there was some frothing at the mouth, but there was no audible sound and no evidence of sensation or suffering. Death was evidently instantaneous and painless.

At 11:33 A. M., the body was placed on the table for examination. At this time the rectal temperature was 100·8 degrees Fahrenheit, and the sphincter was relaxed. The superficial veins of the extremities, especially those of the arms, were empty and collapsed. Incision of the scalp and through the skin of the chest wall showed that all, or nearly all, of the blood in the body had been driven into the head and upper part of the chest and neck, and that rupture of the over-distended vessels had allowed extravasation of blood to take place into the cellular tissues of the scalp and under the skin covering the upper part of the chest, especially near the neck. Here the extravasated blood appeared to be congealed. In marked contrast with the condition of affairs in this location, incision through the abdominal wall showed the tissues to be almost bloodless. Incision into the tissues under the location of the leg electrode showed the same bloodless condition. On removal of the skull cap, and puncture of the dura mater (membrane lining the interior of the skull and inclosing the brain) a great quantity of dark blood escaped, showing that there had been an extravasation into the cranial cavity. This was found to be due to the rupture of the blood vessels. This blood coagulated, but not firmly. A specimen preserved remained fluid and unchanged for days, except that the color became brighter. It was estimated that at least two quarts escaped from the scalp and cranium in removing the brain. On removing the dura mater the vessels on the surface of the brain were seen to be distended and there was evidence of rupture in many places. The same condition prevailed throughout its interior, and congealed blood was found at the base of the brain, a condition incompatible with either consciousness or life.

On opening the chest cavity the lungs appeared normal, but extravasation of blood had taken place into the lung tissues at the upper part.

The heart walls were thin and flabby; the blood retained in the cavity was dark.

On opening the abdominal cavity, the vessels of the intestines, especially those of the small intestines, were distended with blood. The liver was normal but engorged with blood. The kidneys and spleen were normal. The abdominal aorta was empty.

From observations made at the time of the application of the current, which were abundantly substantiated by the result of the autopsy, we conclude that death was instantaneous and painless.

The evidence is, therefore, that a current of 8 amperes, applied through the body at a pressure of 1,740 volts, and representing a power of (1,740 × 8 =) 13,920 watts, or about 18⅔ electrical horse power, will produce instantaneous, painless and absolute death; and that the evidence presented by an examination of the brain alone was sufficient to demonstrate the absolute impossibility of resuscitation.

Although in our opinion there is no hope of resuscitation in cases where, as in this electrical execution, an alternating current of sufficient E. M. F. is deliberately sent through the body of the criminal, yet in all cases of accidental contact with high pressure circuits, in our opinion, efforts for resuscitation should be made, since in most cases of accidents from electricity, either from the imperfection of the contact or its short duration, the current strength passing through the body and the electrical energy expended thereby might only be sufficient to produce a loss of consciousness.

[Continued from SUPPLEMENT, No. 999, page 15970.]

THE COMPOSITION AND CONSTITUTION OF CERTAIN ALLOYS.*

By Dr. C. R. ALDER WRIGHT, F.R.S.

TERNARY ALLOYS.

OUT of the 84 combinations obtainable by taking the nine metals chiefly experimented with, three at a time, 55 are "real" under all circumstances, but the remaining 29 form "ideal" alloys when mixed in proportions lying outside of certain limits which are conveniently expressible as the boundary of a particular area inside a triangle (vide infra).

Theoretically, three different classes of ideal ternary alloys may be distinguished; but as regards the particular metals examined, one of these classes is unrepresented among the various combinations thence derivable. The three classes may be distinguished thus: Let the three constituents be respectively A, B and C; then, by taking them two at a time, three pairs are obtainable, A B, A C and B C. In the first class only one pair, A B, is incapable of mixing in all proportions. In the second class two of the pairs, A B, A C, are incapable of mixing in all proportions. In the third class all three pairs are similarly incapable. The three classes may accordingly be thus tabulated:

	Immiscible Pairs.	Miscible Pairs.
Class 1	A B	A C, B C
Class 2	A B, A C	B C
Class 3	A B, A C, B C	Nil

The class of which no representative is found among the 29 combinations as above is the third; 23 combinations of the first class, however, and six of the second class, can be formed from the nine original metals, viz.:

CLASS I.

A.	B.	C.	
Pb	Zn	Either Sn, Ag, Sb, Cu, or Cd	(5)
Bi	Zn	Do. do.	(5)
Pb	Al	Either Sn, Ag, Sb, or Cu	(4)
Bi	Al	Do. do	(4)
Cd	Al	Either Sn, Ag, Sb, Cu, or Zn	(5)
		Total	23

CLASS II.

A.	B.	C.	
Either Zn or Al	Bi	Pb	(2)
Either Bi or Pb	Al	Zn	(2)
Al	Either Bi or Pb	Cd	(2)
		Total	6

Ternary ideal alloys of the first and second classes, in practice, always divide into pairs of real alloys. A ternary alloy of the third class, however, might, under certain conditions, divide into three real alloys; thus if A could dissolve but little of B or C; B only small quantities of A or C; and C only a little of either A or B, a mixture of A, B and C in approximately equal quantities would necessarily divide into three different ternary alloys; viz.: A containing a little B and C; B with a little A and C; and C containing a little A and B; so that the fused mass would divide into three layers according to the relative densities of the alloys formed.

Although mixtures of three metals possessing this peculiar feature have not been obtained so far, still it is possible to prepare analogous mixtures of non-metallic fluids. Thus, a mixture of approximately equal volumes of castor oil, petroleum (kerosene) and water, when well shaken up, forms a sort of emulsion, which, on standing for some time, separates into three distinct layers.

DETERMINATION OF LIMITS WITHIN WHICH IDEAL TERNARY ALLOYS OF CLASS I ARE FORMED.

In order to deduce accurately the limits for a given trio of metals, a somewhat lengthy series of experiments is requisite, all made at the same temperature. With alloys of the first class this is best effected by taking suitable quantities of the immiscible metals, A and B, and fusing them with gradually increasing proportions of the third metal, C (termed by Sir G. G. Stokes the "solvent" metal).

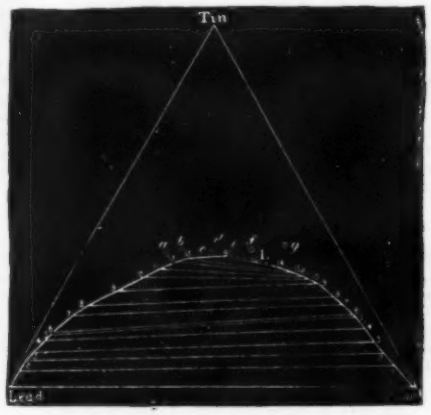
The relative quantities of A and B requisite for any given experiment should be approximately calculated from the results previously obtained, which is readily readily done at sight when the values are graphically represented as described below; the quantities should be such as to develop approximately equal volumes of the two alloys produced, since experience indicates that if one alloy be formed in very much larger quantity than the other, abnormal results are more likely to be produced. By and by the result is arrived at that the limit within which an ideal alloy is produced is passed, so that a real alloy results, the two ends of the compound ingot formed being of practically identical composition; but before this is attained, parts of "conjugate" alloys are produced with each mixture employed. To represent these results graphically, Sir G. G. Stokes has suggested the following method:

A triangle is drawn to scale (perfectly equilateral), and the center of gravity deduced (by a simple process of plotting) of three weights placed respectively at the three corners of the triangle, and in the same ratios as the percentages of the three constituents of the ternary alloy to be delineated. Conveniently the solvent

* The last scientific paper prepared by the distinguished author, a short time before his decease. Read November 5, 1894, before the London section of the Society of Chemical Industry.—From the Journal of the Society.

metal is supposed to be at the apex of the triangle, and the other two at the respective ends of the base. This point then represents the alloy in question; so that, by finding the two points representing the two real alloys into which a given ideal alloy divides, and joining them by a line ("tie line" or "tie"), a visible representation is given of the mode of division of the ideal alloy employed.* A series of alloys with gradually increasing proportions of "solvent" will then give a series of tie lines uniting the pairs of conjugate points respectively obtained from each mixture. By drawing a line through all the points thus deduced for the heavier alloys, and another through those similarly obtained for the lighter ones, two branches or portions of a continuous curve ("critical curve") are deduced, the gap between the ends being the smaller the more nearly the series of mixtures employed approaches to a particular limiting composition, indicated on the diagram by a point toward which all the ties continually approach, and at which they vanish. The exact position of this "limiting point" is calculable with a considerable degree of approximate accuracy from the relative positions of the various pairs of conjugate points, by one or other (or both) of two methods ingeniously devised by Sir G. G. Stokes for the purpose.†

The annexed figure, for example, illustrates the critical curve deduced by means of fourteen tie lines (each the result of several concordant experiments averaged) with mixtures of lead, tin and zinc at near 650° C. The point, L, is the "limiting point," calculated as above; a, b, c, d, e, f and g, represent seven differ-



ent real alloys (actually prepared and found to be such), all lying slightly outside the space inclosed by the critical curve and part of the base line, forming approximately a segment of a circle or of a parabola. Any alloy represented by a point lying inside this space is an ideal alloy; while, if the point representing an alloy lie outside (like a, b, c, etc.), it is a real alloy. In this particular case the configuration of the tie lines is remarkable; the lower ties slope downward to the left (lead side), showing that tin predominates in the heavier alloy, as compared with the lighter one; but the upper ties slope in the opposite direction, indicating that the opposite is the case when the original mixture contains larger proportions of tin. The upper ties converge toward a sort of central point; the middle portion of that part of the right hand side of the critical curve where this is manifest corresponds with a mixture of metals containing tin and zinc close to the ratio represented by $SnZn_4$, suggesting that the tendency toward the fraction of the definite atomic compound thus indicated is the cause of the convergence. The tie line exhibiting the maximum amount of slope (No. 5) represents a point on the left hand branch of the curve where the tin and lead are approximately in the ratio $SnPb_2$, suggesting the possibility of the existence of this definite atomic compound being the cause of the direction of slope being different for the lower ties from that found for the upper ones, a notion strengthened by the facts that a precisely similar double sloping configuration of ties is observed with lead-tin-aluminum mixtures, the maximum slope of the lower ties also corresponding with $SnPb_2$, whereas no double sloping sets of ties are observed with any alloys not containing simultaneously lead and tin. In similar fashion the systems of tie lines and the critical curves thence deduced for the other twenty-two ternary alloys of the first class have been more or less minutely determined and delineated.‡ From these experiments, as far as at present completed, the following general conclusions may be drawn as regards alloys of Class I:

1. With each ternary combination of metals the position of the critical curve varies with the temperature in such fashion that the curve for the higher temperature lies inside of that for the lower temperature. Toward the base of the curve (i. e., for those mixtures containing smaller proportions of "solvent" metal) the effect of variation of temperature is but slightly marked; but nearer to the limiting point (i. e., for mixtures containing quantities of "solvent" approaching the maximum possible consistent with the alloy remaining ideal) the effect is much greater; in some cases a comparatively small variation in temperature makes all the difference whether a given mixture of metals forms an ideal alloy dividing into two real alloys exhibiting a considerable amount of difference in composition or produces a real alloy not dividing at all.§

2. The position of the limiting point corresponds with a ratio between the two immiscible metals which is not constant, but varies widely with the nature of the solvent metal.

3. In most cases the contour of the critical curve exhibits no marked sinuosity or irregularity; but in a few instances it shows a marked bulge outward or notch inward, which reaches its maximum development when the ratio between the solvent metal and one of the immiscible metals approaches toward that indicating some definite atomic compound. The atomic compounds $AgZn_4$, Ag_2Zn_5, Bi_2Sb_3 and CuZn are thus pretty clearly defined by bulges and notches.

4. In some few cases, although no irregularity of outline of the critical curve is noticeable, yet the configuration of the tie lines exhibits some peculiarity, leading to the idea that an atomic compound of some of the metals, which affects the relative distribution of the metals in the two conjugate alloys, is formed: e. g., the above-described double direction of slope with ZnPbSn and AlPbSn alloys suggesting the compound $SnPb_2$, and the convergence toward some central point of a number of tie lines with ZnPbSn alloys suggesting the compound $SnZn_4$. The existence of the compound Pb_3Cd is clearly indicated by a convergence of this kind.

In the majority of cases, however, no change in direction of slope of tie lines is noticeable throughout the entire series, all sloping either to the right or to the left. No fixed law regulating the direction of slope has been arrived at; with silver or copper as solvent, when the results are plotted, the heavier of the two immiscible metals being toward the left, the ties invariably slope downward to the left (i. e., the heavier alloy formed contains less solvent than the lighter), whether the immiscible pair be PbZn, BiZn, PbAl, BiAl or CdAl. With tin as solvent, on the other hand, the ties invariably slope to the right, except those obtained with smaller tin proportions in the case of PbZnSn and PbAlSn alloys, when the slope is toward the left, probably on account of the effect of the formation of a definite compound Pb_3Sn, as above described. With antimony as solvent, however, the ties all slope to the left with the certain immiscible pairs (PbZn, PbAl, BiAl), but to the right with others (BiZn); similarly, with cadmium as solvent, the ties all slope to the left with the immiscible pair PbZn and to the right with the pair BiZn. With zinc as solvent in the alloys of CdAlZn, the ties slope to the left. It would thence seem that, while the nature of the solvent metal obviously influences the direction of slope, and while the ties slope to the left in the larger number of cases out of the 23 possible ones, it cannot be deduced that one given solvent always gives a slope to the left and another one to the right, and so on.

5. As regards the dimensions of the segment like areas within which real alloys are not formed in different cases, it is noticeable that on comparing the critical curve obtained with a given trio of metals, of which lead is one, with that obtained with the corresponding trio, where bismuth is used instead of lead, the latter always lies inside the former. In similar fashion, when zinc is displaced in a given trio by aluminum, the curve obtained with the latter metal lies outside that obtained with the former. Similar relationships also apply (but not invariably) to certain pairs of solvent metals, the temperature and the two immiscible metals being the same; thus, whether these two metals be lead and zinc, lead and aluminum, bismuth and zinc, bismuth and aluminum, or cadmium and aluminum, the curve obtained with silver as solvent metal always lies outside that formed with copper; and apparently the curve with antimony always lies inside that observed with tin. On the other hand, although the curve with tin as solvent lies inside that with Ag (and a fortiori inside that with Cu) in the four cases where the immiscible pairs are respectively PbZn, BiZn, PbAl and BiAl, yet this is not the case when the immiscible pair is CdAl; the Sn curve then lying outside both the Ag curve and the Cu curve.

TERNARY IDEAL ALLOYS OF THE SECOND CLASS.

In order to depict graphically the results arrived at by the analysis of the real alloys into which ideal alloys of the second class divide themselves, the same triangular system may be conveniently adopted, with the difference that the two miscible metals are placed at the ends of the base line, and the third metal (not miscible completely with either of the others) at the apex of the triangle. The limits within which ideal alloys only are formed are traced out by plotting the conjugate points and connecting tie lines as before, the result in all cases being a space of very different shape from that deduced with alloys of the first class. Instead of this space being bounded by part of the base line and a curve approximating more or less to the arc of a circle or part of a parabola, it is a quadrilateral, two of the sides of which are parts of the sides of the triangle, while the other two are curved lines running more or less horizontally, and consequently cutting off from the triangle a three-sided portion at the top, and a four-sided part at the bottom. Mixtures corresponding with points lying in either of the upper or lower areas are real alloys, and do not divide into two on standing molten; while mixtures corresponding with points lying inside the intervening quadrilateral figure are ideal alloys, and divide into two real ones, one situated on the one line and the other on the other line.

QUINARY ALLOYS.

Of the 126 quinary combinations obtainable from the nine metals employed (95 of which are capable of forming ideal alloys), obviously a yet larger number of classes and subdivisions may be a priori formulated, many of which have representatives among the combinations deducible from the nine metals used: thus the alloys—

Zn, Pb, Cd, Sn, Ag
Al, Cd, Sn, Ag, Cu

contain one ideal binary pair, A B; while the following—

Zn, Pb, Bi, Sn, Ag
Al, Pb, Cd, Ag, Cu

contain two such pairs, A B, A C; and so on.

SEXENARY ALLOYS.

Of the 84 sexenary alloys obtainable, only nine are real; viz., the seven formed by taking each six out of the series—

Pb, Bi, Sn, Ag, Cu, Sb, Cd

(i. e., by omitting each one in turn); and the two following:

Al, Zn, Sn, Ag, Cu, Sb
Zn, Cd, Sn, Ag, Cu, Sb

SEPTENARY, OCTENARY, AND NONARY ALLOYS.

Of the 36 septenary combinations deducible, only one is real; viz.:

Pb, Bi, Sn, Ag, Cu, Cd, Sb.

None of the nine combinations obtained by taking the metals eight at a time is capable of giving a real alloy, excepting when the constituents are mixed outside of certain limiting proportions; and the same remark is true of the mixcure obtained by putting together all nine metals; thus a mixture, of which the great bulk consists of any one of the five ideal binary alloys PbZn, PbAl, BiZn, BiAl, CdAl, together with small admixtures of the remaining metals, will divide into two different alloys, consisting, for example, of—

1. Chiefly Pb, with small quantities of the other eight metals.

2. Chiefly Zn, with small quantities of the other eight metals.

The chairman said that the paper just read had an interest far exceeding the interest of the subject, it being the last work of their dear friend Dr. Alder Wright. Nearly every member of the Society knew him, and to know him was to admire him and revere his memory. The paper now before them was an illustration of the thorough manner in which Dr. Wright did all his work. It was monumental in character, covering the whole history of the subject. Probably few members would wish to discuss the matter that night, but he was happy to say that there was present with them a fellow student of Dr. Wright, one who had known him from his boyhood, namely, their worthy president, and he would ask him to say a few words, if not on the paper itself, at any rate on the author.

The President: I do not propose, in the very few words that I shall say to the meeting in response, sir, to your invitation, to utter anything in the way of contribution to a discussion on the matter of Dr. Wright's last paper. Indeed, I am quite incapable of contributing anything which would be worthy of being listened to on that subject. But I should not like this opportunity to pass without saying something on the merits of a man whom I have known intimately for 30 years, and who is now no longer to come among us. Dr. Wright, his friend Mr. Watson Smith, who has just read to us his last paper, and I, began our chemical careers together, working shoulder to shoulder in that laboratory in the rear of Richard Cobden's old house in Quay Street, Manchester, which was the place in which the now palatially-housed Owens College had its humble beginning. As you have said, sir, to know Wright was to admire him, but I will say more: to know Wright well was to love him. For beneath the surface aspect of the man—beneath all his eccentricities and peculiarities—there was a great substratum of genuine worth and high personal character. There was a certain large-heartedness about the man without the least trace of malice or uncharitableness. He was often misunderstood; people occasionally said harsh things of him; but no unkind word of retaliation—no word which could be misconstrued to his quondam opponents' demerit—was ever uttered by him. The very directness and straightforwardness of his speech and manner was indeed the keynote to his character. There is in the paper we have just heard the melancholy interest which springs from the circumstance that it is the last contribution which this or any other society will ever receive from him. That of itself gives the paper a peculiar importance to us on this the first night of a new year in the existence of our society—a night upon which we might have reasonably hoped to see Wright once more among us, and to hear his voice again; for as the minutes just read to you show, it was actually raised among you at your very last meeting. Indeed, we should have had from him the very paper which our editor has just read, and its reading would have been accompanied by a wealth of illustration and by an amount of exposition which were characteristic of him. A man of clear ideas, with a very considerable vocabulary, and power and felicity of expression, Wright was, indeed, one of the very best expositors I have ever heard. This charm we have missed to-night—the charm which comes from the personal interest which the writer would himself have thrown into his communication. There is an aspect of the paper which struck me forcibly, as no doubt it did many here—namely, the indication it affords of the extraordinary versatility of its author. That versatility, that remarkable receptivity and power of adaptation to all sorts of fresh ideas, was characteristic of Wright from his student days. The ease and rapidity with which he accomplished his college tasks always appeared marvelous to his fellow students. It was so not only in chemistry, but he excelled equally in every other department of knowledge which he took up as a student: physics, mathematics, classics—even in such subjects as Hebrew and the Greek Testament—in all he gained distinction, as the old prize lists at Owens College testify. His published papers range literally over every department of chemistry, pure and applied. Now he treats of the constitution of whole groups of the alkaloids, and was, as you know, concerned in discovering one of the most important and valuable of the artificial members of the series—apomorphine. Now he deals with a most difficult branch of organic chemistry—the nature of the essential oils, and the very minute differences to be observed in the physical characters of the isomeric terpenes. Then he passes to various sections of inorganic chemistry, and from them to industrial applications of both organic and inorganic chemistry. He was as much at home in discoursing upon the intricacies of the manufacture of alkali and sulphuric acid as in discussing the characters and constitution of the opium alkaloids. In physical chemistry, too, he finds a field for his energy. The existence of hydrogenium is established, and Wright is concerned to determine certain of its physical properties. Indeed, his first published paper was on a section of physical chemistry, the action of light on silver salts, and in rereading that paper a few days ago I was greatly struck with its power and promise—the precision of its statements, its orderly arrangement, and literary merit. He did not think that the whole of chemistry was concerned with the study of carbon compounds—he was

* The ideal alloy itself is necessarily represented by some point situated in the tie line between its ends.

† Proceedings Royal Society, 49, 1890—1891, 174—178.

‡ Proceedings Royal Society, 50, Part V., 382.

§ Fluids other than melted metals exhibiting the same characters as to mutual miscibility or otherwise, behave in precisely the same way; thus a mixture of water, chloroform and acetic acid behaves in a fashion exactly parallel with that observed with a molten mixture of zinc, lead and tin. Near the limiting point the sensitiveness to temperature variation is very great.—Proc. Roy. Soc., 50, Part V.

not merely a benzological man. In this his last paper we have one more instance of the catholicity of his tastes and the range of his acquirements. For it is to my knowledge the condensed expression of many years of thought and a great amount of experimental work. I could say much more about Wright's personal character—about his worth as a man and his stanchness as a friend. One indication of his qualities you have gleaned from the circumstances which led up to the reading of this paper. He gave his word to our secretary that this paper should be prepared; and under the most trying conditions, while suffering from pain and great physical prostration, he fulfilled his promise. This trustworthiness was eminently characteristic of him, and was thoroughly in accord with my lifelong experience of his character and qualities. Those who were best acquainted with him, and knew the circumstances under which much of his work was done, regarded the amount and quality of it as nothing short of marvelous, and the only solution I can offer is that he found in work itself solace and comfort under the physical pain and consequent mental depression from which he had for many years suffered.

[Continued from SUPPLEMENT, 999, page 15965.]

EXPLOSIVES AND THEIR MODERN DEVELOPMENT.*

By Professor VIVIAN B. LEWES.

LECTURE I.—CONTINUED.

A DAY'S production at the royal government factory represents about 100 barrels or 10,000 lb. of powder, and it is essential that this large quantity should be as nearly as possible unform in itself, so that when fired in charges the results, both as to muzzle velocity and pressure, should only vary within extremely narrow limits.

The 10,000 lb. of powder, however, are made in many machines, and it is manifest that not only atmospheric conditions, but also slight differences in the methods of work employed by the different men tending the machines, will make considerable differences in the batches turned out by each machine, and, if unadjusted, the batches of powder would of necessity give irregular results when used in guns.

In order to overcome this the batches of powder are blended, that is to say, the results obtained by firing a charge or charges from each batch are carefully noted, and the prisms from each batch are then mixed in such proportions as to give uniformity in the results obtained from the whole output.

The pressure exerted in the breech of a gun during the explosion is measured by a contrivance called a "crusher gauge," which consists of a steel cylinder into which a collar screws gas tight, and carries a steel piston also rendered air tight by a gas check. A small piece of copper, which has been compressed to a known density by exposing it to a hydraulic pressure of 12 tons, and which is 0·5 of an inch in length, is placed in the bottom of the steel cylinder, the piston is then put in its place, the collar screwed up, the gas check fitted, and the crusher gauge placed in the base of the cartridge, the solid end of the cylinder being against the end of the gun, and the gas check toward the projectile. On firing the gun the gauge is subjected to the full pressure developed by the explosion of the powder, which forces the steel piston down upon the copper cylinder and compresses it. The crusher gauge, having no powder behind it, is left after the explosion in the breech of the gun, and is opened, the length of the copper being accurately measured on a micrometer scale, the amount of compression indicating the pressure in the breech of the gun. Used in this way, the crusher gauge gives very reliable results, but it has been shown that when inserted in the wall of the gun, certain waves of pressure and difficulties of adjustment occasionally interfere with the results obtained.

The muzzle velocity of the shot is determined by means of the chronograph. Two screens are arranged, one about 120 feet from the muzzle of the gun and the second 120 feet beyond the first. These screens consist of wooden frames strung with fine copper wire, the disruption of a single strand of which is sufficient to break the flow of the galvanic current. In the Boulenge chronograph, a current from a battery of eight Bunsen cells flows through these wires and back to the instrument house, where the wire from each frame is coiled round a separate soft iron core, and converts it into an electro-magnet, each of which attracts and holds a rod of steel. The electro-magnet in connection with the second frame is fixed at a lower level than the electro-magnet connected with the first, and carries a short rod with a weight at the bottom, while the first magnet is at a much higher level, and carries a longer rod. The current being allowed to pass through both electro-magnets, the rods are suspended in position. By pressing a key both circuits can be simultaneou-ly broken, with the result that both the rods are liberated, and drop down guide tubes; the short rod strikes a catch, and causes a knife edge to be brought against the longer falling iron, and to make a nick in it. When both rods are liberated simultaneously, this nick occurs at a definite place. The current is then allowed to pass, the rods hung on the electro-magnets, and the gun containing the charge, the power of which is to be tested, is fired, the projectile passing through the screens and breaking the current by cutting the wires. Under these conditions the long rod is liberated a fraction of a second sooner than the shorter rod, the result being that the nick of the knife blade is no longer in the original place. By measuring the distance between the two nicks, and knowing the length of time to which this is equivalent, allowance being made for the time taken in liberating the knife blade, etc., the interval of time which elapses while the projectile is passing between the screens can be calculated, and, being corrected for the distance of the first screen from the muzzle, gives the muzzle velocity of the projectile.

Each batch of powder made is tested in this way, and the batches are then blended according to the results they have given, so as to obtain a powder best suited to the work required of it.

The best proof that can be deduced to show that the pressure gauge, when used in this way in the breech of the gun, gives reliable results, is that an expert operator can from the pressure recorded predict within a few feet per second what the muzzle velocity as recorded by the chronograph will be.

The uniformity of composition obtained in the Waltham processes as described may be inferred from the following tables of tests made on various batches of E.X.E. and S.B.C. powder, which show the very small variations in muzzle velocity and pressure given by these powders.

LOT 54 E.X.E.

Charge.	Muzzle Velocity. Feet per second.	Pressure. Tons per square inch.
48 lb.	1,981	18·8
	1,978	16·6
	1,982	16·45
	1,977	16·4
	1,980	16·55
	Mean 1,980	16·58

LOT 36 S.B.C.

Charge.	Muzzle Velocity. Feet per second.	Pressure. Tons per square inch.
360 lb.	2,020	14·75
	2,020	14·85
	2,025	14·80
	Mean 2,022	14·80

It must, however, be clearly borne in mind that this uniformity of velocity and pressure can only be obtained by absolute uniformity in density and composition of the powder, and that in order that these prism powders should yield the above results it is essential that they should contain from 1·7 to 2·2 per cent. of moisture. This shows the great importance of keeping the powder magazines of a ship as cool as possible, as the hygroscopic character of the straw charcoal burnt at a low temperature will enable the new prism powders to retain the proper amount of moisture under all normal atmospheric conditions, but when exposed to the high temperatures often observed in ill-ventilated magazines on board ship, situated near the boilers or engines, they must of necessity lose a certain amount of water, and abnormal pressures obtained from badly kept powders are the result.

The serious effect which driving out the moisture has upon the pressure developed in the gun on firing is well shown in the following table:

Percentage of moisture in powder.	Pressure in tons per square inch.	Muzzle velocity in feet per second.
1·5	10·75	1,497
1·0	20·18	1,523
0·7	22·02	1,545

On some of our new battle ships the magazines must from their position become overheated, and this will prove even a more serious question with the new smokeless powder than it is now with the E.X.E. and S.B.C. powders, but the trouble could easily be overcome by surrounding the magazine with a double water tight bulkhead, through which sea water could readily be made to circulate. As the temperature of the ocean only varies to a small extent, a fairly constant temperature could be maintained in the magazine, and at the same time greater safety insured.

Great attention is also paid to the density of these powders, any decrease in density tending to increase the pressure.

Density.	Velocity. Feet per second.	Pressure. Tons per square inch.
1·790	2,066	17·5
1·800	1,944	14·6
1 820	1,894	12·7

The way in which powder burns is influenced to a great extent by the conditions under which it is ignited; if some powder is placed in a cylinder and touched with a hot wire, it catches fire and burns with a "puff," but if the powder is heated in a test tube at a certain temperature, it explodes. In the one case the combustion spreads from grain to grain, while in the second case the whole mass is heated to a high temperature, and the increase in rapidity in burning is manifested by explosion. Variation in pressure has a considerable influence upon the rate at which powder will burn, as under low pressure the flame from the powder escapes so rapidly that its power of passing on the combustion from grain to grain becomes seriously impaired.

Up to 1856, the chemical changes taking place when gunpowder was fired were generally expressed by an equation more remarkable for its simplicity than its correctness. This equation the researches of Bunsen and Schischkoff in 1857 showed to be untenable.

In 1875 and 1880 Nobel and Abel published their valuable researches upon explosives, from the results of which they came to the conclusion that the same description of powder exploded several times in succession will yield the products of combustion in proportions which vary in each experiment, and that, therefore, the metamorphosis of gunpowder cannot be represented by a chemical equation.

This view was criticised by Dr. H. Debus, who in the Bakerian lecture to the Royal Society in 1882 showed that the chemical reactions taking place during the combustion of gunpowder are in the first place very simple, the oxygen of the potassic nitrate converting the carbon into carbon monoxide (CO) and carbon dioxide (CO_2), while the nitrogen is liberated; the potassium unites partly with carbon dioxide and oxygen to form potassic carbonate K_2CO_3, and partly with sulphur and oxygen to form potassic sulphate K_2SO_4, and the following might be taken as the simplest equation representing this principal reaction:

Potassic Nitrate. Charcoal. Sulphur.

$$4KNO_3 + 4C + S$$

Carbonate. Potassic Sulphate. Potassic Acid. Carbonic Oxide. Carbonic Nitrogen.

$$= K_2CO_3 \quad K_2SO_4 + 2CO_2 + CO = 2N_2$$

but this equation does not even approximately represent the proportions in which the ingredients are present in powder, the ordinary service powders having the molecular proportion $16KNO_3 + 21C + 6S$, while the products of combustion vary with every change in the methods of burning, also with the pressure under which the combustion takes place. Probably also the size of the charge used exercises an influence on the products.

Moreover, the powder contains moisture and the carbon contains hydrogen and oxygen condensed in its pores, and the hydrogen from both these sources plays an important part in the reaction taking place in the breech of a gun, so that to represent the chemical changes taking place by an equation with any degree of accuracy is an absolute impossibility.

It is probable from the researches of Bunsen and Schischkoff, Linck, Karolyi, Nobel and Abel, that during the combustion of gunpowder in the breech of a gun two distinct stages may be traced.

The first reaction is a process of oxidation occupying a very short space of time and constituting the explosion, during which, as in the previous equation, potassic sulphate, potassic carbonate, carbon dioxide and traces of monoxide, together with nitrogen, are formed. The proportions in which the original ingredients are present, and the proportions of the resulting products showing that the equation must be taken as:

$$16KNO_3 + 13C + 5S = 3K_2CO_3 + 5K_2SO_4 + 9CO_2 + CO + 8N_2$$

while some carbon and sulphur are left unacted upon, and these in the second stage of the action, which goes on while the products of the first stage are under great pressure and at a very high temperature, partly reduce the potassic carbonate and potassic sulphate, with formation of more carbon dioxide and potassic disulphide according to the equation:

$$4K_2CO_3 + 7S = K_2SO_4 + 3K_2S_2 + 4CO_2$$
$$4K_2SO_4 + 7C = 2K_2CO_3 + 2K_2S_2 + 5CO_2$$

During the combustion of the powder also a small quantity of the sulphur present unites with the metal of the gun, and some also with both the hydrogen occluded by the charcoal and that liberated by the decomposition of the moisture present in the powder, giving small traces of sulphureted hydrogen gas; and deducting an atom of sulphur from the equation in order to allow for this secondary action, it is found that the final combustion of the ordinary service powder can be approximately represented by the equation:

Potassic Nitrate. Charcoal. Sulphur.

$$16KNO_3 + 21C + 5S$$

Potassic Carbonate. Potassic Sulphate. Potassic Sulphide. Carbonic Acid. Carbonic Oxide.

$$= 5K_2CO_3 + K_2SO_4 + 2K_2S_2 + 13CO_2 + 3CO$$

Nitrogen.

$$8N_2$$

Using this equation, the volume of gas generated by one gramme of the powder can be readily calculated.

			Grammes.
Saltpeter.....	$16KNO_3$	= 16 × 101 =	1,616
Carbon.....	21C	= 21 × 12 =	252
Sulphur..... .	5S	= 5 × 32 =	160
			2,028

The gaseous products of the combustion are:

		Liters.	Cubic Centimeters.
Carbon dioxide	$= 13CO_2$	13 (22·36) =	290·680
Carbon monoxide	= 3CO	3 (22·36) =	67·080
Nitrogen	$= 8N_2$	8 (22·36) =	178·880

2,028 grammes of powder, therefore, yield, according to this equation, 536,640 cubic centimeters of gas, measured at 0° C. and 760 mm. pressure, or one gramme of the powder yields 264·6 c. c. of gas. The mean of the results experimentally obtained by Captain Nobel and Sir Frederick Abel for pebble R.L.G. and F.G. powders is, under these conditions, 263·74 c. c. of gas, a quantity which, considering the risk of experimental error and slight unavoidable inaccuracies, agrees wonderfully closely with the calculated result.

The volume of the gas being measured at 0° C. and 760 mm. pressure, it is evident that at the moment of explosion the high temperature attained will expand it to an enormously larger volume.

Nobel and Abel found, as the mean of a number of experiments, that one gramme of powder during combustion gave off enough heat to raise 714·5 grammes of water from 0° C. to 1° C., that is, gave out 714·5 thermal units, while Dr. Debus calculated that the heat generated by the reactions between the saltpeter, sulphur and charcoal in one gramme of English service powder is 660 thermal units, but the difference would be much smaller if the amount of heat produced by the action of the sulphur upon the iron of the apparatus were known and could be subtracted from the experimental number.

Nobel gives the composition of the residue and gases formed during the combustion of cocoa powder under pressure as:

SOLID RESIDUE.

Potassium carbonate...	64·12
Potassium bicarbonate....	13·55
Potassium sulphide.	none
Potassium sulphate.....	22·33
	100·00

* Four lectures recently delivered before the Society of Arts, London.—From the Journal of the Society.

GASES.	
Carbon dioxide	51·30
Carbon monoxide	3·42
Hydrogen	3·26
Marsh gas	0·31
Nitrogen	41·71
	100·00

giving at standard temperature and pressure 195 liters of permanent gases and 837 units of heat for each kilogramme of powder fired.

The large quantity of water vapor, however, formed during the combustion of the cocoa powder makes the volume of gas at the moment of explosion practically the same as in the case of black pebble powder.

One kilogramme of powder gives at standard temperature and pressure:

	Black.	Cocoa.
Permanent gas liters	295·7	195·4
Water vapor	40·9	122·5
	316·6	317·9

When fired under ordinary atmospheric pressure, the products of combustion are very different, large quantities of potassic nitrite being left undecomposed. By lowering the percentage of sulphur in the powder the rate of combustion is made slower, and at the same time a decrease in the volume of permanent gases and an increase in the heat units evolved follows.

In 1891 Dr. Debus published a very valuable paper in which he shows that all gunpowder of rational composition may be regarded as being built up of three elementary mixtures:

1.—4 KNO_3 + 5 C called P
2.—2 KNO_3 + 1 C + S " Q
3.—2 KNO_3 + 3 C + 2 S " R

and the properties of the powder vary with the proportion in which the three are present.

English black powder, for instance, may be represented as:

2 P 1 Q 3 R

2 P = 8 KNO_3 + 10 C
1 Q = 2 KNO_3 + 1 C + 1 S
3 R = 6 KNO_3 + 9 C + 6 S

16 KNO_3 + 20 C + 7 S

On analyzing this powder it is found that the proportions are by experiment

16 KNO_3 + 21·2 C + 6·8 S

which, considering that powder is a mechanical mixture, is in close accordance with the theory. In the same way

French powder = 2 P + 5 Q + 4 R
French rifle = 2 P + 2 Q + 3 R
Prussian powder = 2 P + 3 R
Cocoa = 2 P + 1 Q

These mixtures differ from one another in their properties, as P develops the greatest energy; Q develops the greatest heat; R develops the largest volume of gas. The amount of gas evolved by R is nearly double that given off by Q, while the heat evolved by R is only half that given by Q, so that in actual energy Q and R are nearly equal. In practice, however, it is of great importance in which form the energy is supplied. One gramme of Q gives nearly the same amount of energy as one gramme of R, but the action would be very different, as Q produces more heat energy and R more gas energy. The result of this is that the action of Q is more that of a blow, while R yields a steady pressure.

Knowing these factors, the composition of a powder can be arranged for in the work which it has to do. Artillery powders would consist chiefly of mixtures of Q and R, varying in proportion according to the size of the gun. Rifle powder and sporting powder would be rich in Q, while P, being nearly 29 per cent. stronger than Q or R, would increase the strength of the mixtures of which it formed part.

[FROM NATURE.]

ARGON, THE NEW CONSTITUENT OF THE ATMOSPHERE.*

I. DENSITY OF NITROGEN FROM VARIOUS SOURCES.

IN a former paper † it has been shown that nitrogen extracted from chemical compounds is about half per cent. lighter than "atmospheric nitrogen."

The mean numbers for the weights of gas contained in the globe used were as follows:

From nitric oxide	2·3001
From nitrous oxide	2·2990
From ammonium nitrite	2·2987

while for "atmospheric nitrogen" there was found—

By hot copper, 1892	2·3103
By hot iron, 1893	2·3100
By ferrous hydrate, 1894	2·3102

At the suggestion of Prof. Thorpe, experiments were subsequently tried with nitrogen liberated from urea by the action of sodium hypobromite. The hypobromite was prepared from commercial materials in the proportions recommended for the analysis of urea. The reaction was well under control, and the gas could be liberated as slowly as desired.

In the first experiment the gas was submitted to no other treatment than slow passage through potash and phosphoric anhydride, but it soon became apparent that the nitrogen was contaminated. The "inert and inodorous" gas attacked vigorously the mercury of the Topler pump, and was described as smelling like a dead rat. As to the weight, it proved to be in excess even of the weight of atmospheric nitrogen.

The corrosion of the mercury and the evil smell were in great degree obviated by passing the gas over hot metals. For the fillings of June 6, 9 and 13, the gas passed through a short length of tube containing copper in the form of fine wire heated by a flat Bunsen burner, then through the furnace over red hot iron, and back over copper oxide. On June 19, the furnace tubes were omitted, the gas being treated with red hot copper only. The mean result, reduced so as to correspond with those above quoted, is 2·2985.

Without using heat, it has not been found possible to prevent the corrosion of the mercury. Even when no urea is employed, and air simply bubbled through, the hypobromite solution is allowed to pass with constant shaking over mercury contained in a U tube, the surface of the metal was soon fouled.

Although the results relating to urea nitrogen are interesting for comparison with that obtained from other nitrogen compounds, the original object was not attained, on account of the necessity of retaining the treatment with hot metals. We have found, however, that nitrogen from ammonium nitrite may be prepared without the employment of hot tubes whose weight agrees with that above quoted. It is true that the gas smells slightly of ammonia, easily removable by sulphuric acid, and apparently also of oxides of nitrogen The mean result from three fillings is 2·2987.

It will be seen that, in spite of the slight nitrous smell, there is no appreciable difference in the densities of gas prepared from ammonium nitrite with and without the treatment by hot metals. The result is interesting as showing that the agreement of numbers obtained for chemical nitrogen does not depend upon the use of a red heat in the process of purification.

The five results obtained in more or less distinct ways for chemical nitrogen stand thus:

From nitric oxide	2·3001
From nitrous oxide	2·2990
From ammonium nitrite purified at a red heat	2·2987
From urea	2·2985
From ammonium nitrite purified in the cold	2·2987
Mean	2·2990

These numbers, as well as those above quoted for "atmospheric nitrogen," are subject to a deduction of 0·0006 for the shrinkage of the globe when exhausted.* If they are then multiplied in the ratio of 2·3108 : 1·2572, they will express the weights of the gas in grammes per liter. Thus as regards the mean numbers, we find as the weight per liter under standard conditions of chemical nitrogen 1·2505, that of atmospheric nitrogen being 1·2572.

It is of interest to compare the density of nitrogen obtained from chemical compounds with that of oxygen. We have $N_2 : O_2 = 2·2984 ; 2·6276 = 0·87471$; so that if $O_2 = 16$, $N_2 = 13·9954$. Thus, when the comparison is with chemical nitrogen, the ratio is very nearly that of 16 : 14; but if "atmospheric nitrogen" be substituted, the ratio of small integers is widely departed from.

To the above list may be added nitrogen prepared in yet another manner, whose weight has been determined subsequently to the isolation of the new dense constituent of the atmosphere. In this case nitrogen was actually extracted from air by means of magnesium. The nitrogen thus separated was then converted into ammonia by action of water upon the magnesium nitride, and afterward liberated in the free state by means of calcium hypochlorite. The purification was conducted in the usual way, and included passage over red hot copper and copper oxide. The following was the result:

Globe empty, October 30, November 5.	2·82313
Globe full, October 31	0·52395
Weight of gas	2·29918

It differs inappreciably from the mean of other results, viz., 2·2990, and is of special interest as relating to gas which at one stage of its history formed part of the atmosphere.

Another determination, with a different apparatus, of the density of "chemical" nitrogen from the same source, magnesium nitride, which had been prepared by passing "atmospheric" nitrogen over ignited magnesium, may here be recorded. The sample differed from that previously mentioned, inasmuch as it had not been subjected to treatment with red hot copper. After treating the nitride with water, the resulting ammonia was distilled off, and collected in hydrochloric acid; the solution was evaporated by degrees, the dry ammonium chloride was dissolved in water, and its concentrated solution added to a freshly prepared solution of sodium hypobromite. The nitrogen was collected in a gas holder over water which had previously been boiled, so as, at all events, partially to expel air. The nitrogen passed into the vacuous globe through a solution of potassium hydroxide, and through two drying tubes, one containing soda lime, and the other phosphoric anhydride.

At 18·38° C. and 754·4 mm. pressure, 162·843 c. c. of this nitrogen weighed 0·18963 gramme. Hence,

Weight of 1 liter at 0° C. and 760 mm. pressure = 1·2521 gramme.

The mean result of the weight of 1 liter of "chemical" nitrogen has been found to equal 1·2505. It is, therefore, seen that "chemical" nitrogen, derived from "atmospheric" nitrogen, without any exposure to red hot copper, possesses the usual density.

Experiments were also made which had for their object to prove that the ammonia produced from the magnesium nitride is identical with ordinary ammonia and contains no other compound of a basic character. For this purpose the ammonia was converted into ammonium chloride, and the percentage of chlorine determined by titration with a solution of silver nitrate which had been standardized by titrating a specimen of pure sublimed ammonium chloride. The silver solution was of such a strength that 1 c. c. precipitated the chlorine from 0·001701 gramme of ammonium chloride.

(1) Ammonium chloride from orange-colored sample of magnesium nitride contained 66·35 per cent. of chlorine.

(2) Ammonium chloride from blackish magnesium nitride contained 66·35 per cent. of chlorine.

(3) Ammonium chloride from nitride containing a large amount of unattacked magnesium contained 66·30 per cent. of chlorine.

Taking for the atomic weights of hydrogen H = 1·0032, of nitrogen N = 14·04, and of chlorine Cl = 35·46, the theoretical amount of chlorine in ammonium chloride is 66·27 per cent.

From these results—that nitrogen prepared from magnesium nitride, obtained by passing "atmospheric" nitrogen over red hot magnesium has the density of "chemical" nitrogen, and that ammonium chloride prepared from magnesium nitride contains practically the same percentage of chlorine as pure ammonium chloride—it may be concluded that red hot magnesium withdraws from "atmospheric nitrogen" no substance other than nitrogen capable of forming a basic compound with hydrogen.

II. REASONS FOR SUSPECTING A HITHERTO UNDISCOVERED CONSTITUENT IN AIR.

When the discrepancy of weights was first encountered, attempts were naturally made to explain it by contamination with known impurities. Of these the most likely appeared to be hydrogen, present in the lighter gas in spite of the passage over red hot cupric oxide. But inasmuch as the intentional introduction of hydrogen into the heavier gas, afterward treated in the same way with cupric oxide, had no effect upon its weight, this explanation had to be abandoned, and finally it became clear that the difference could not be accounted for by the presence of any known impurity. At this stage it seemed not improbable that the lightness of the gas extracted from chemical compounds was to be explained by partial dissociation of nitrogen molecules, N_2, into detached atoms. In order to test this suggestion, both kinds of gas were submitted to the action of the silent electric discharge, with the result that both retained their weights unaltered. This was discouraging, and a further experiment pointed still more markedly in the negative direction. The chemical behavior of nitrogen is such as to suggest that dissociated atoms would possess a high degree of activity, and that even though they might be formed in the first instance, their life would probably be short. On standing they might be expected to disappear, in partial analogy with the known behavior of ozone. With this idea in view, a sample of chemically prepared nitrogen was stored for eight months. But at the end of this time the density showed no sign of increase, remaining exactly as at first.*

Regarding it as established that one or other of the gases must be a mixture, containing, as the case might be, an ingredient much heavier or much lighter than ordinary nitrogen, we had to consider the relative probabilities of the various possible interpretations. Except upon the already discredited hypothesis of dissociation, it was difficult to see how the gas of chemical origin could be a mixture. To suppose this would be to admit two kinds of nitric acid, hardly reconcilable with the work of Stas and others upon the atomic weight of that substance. The simplest explanation in many respects was to admit the existence of a second ingredient in air from which oxygen, moisture, and carbonic anhydride had already been removed. The proportional amount required was not great. If the density of the supposed gas were double that of nitrogen, half per cent. only by volume would be needed; or if the density were but half as much again as that of nitrogen, then 1 per cent. would still suffice. But in accepting this explanation, even provisionally, we had to face the improbability that a gas surrounding us on all sides and present in enormous quantities could have remained so long unsuspected.

The method of most universal application by which to test whether a gas is pure or a mixture of components of different densities is that of diffusion. By this means Graham succeeded in effecting a partial separation of the nitrogen and oxygen of the air, in spite of the comparatively small difference of densities. If the atmosphere contain an unknown gas of anything like the density supposed, it should be possible to prove the fact by operations conducted upon air which had undergone atmolysis. This experiment, although in view from the first, was not executed until a later stage of the inquiry (§ 6), when results were obtained sufficient of themselves to prove that the atmosphere contains a previously unknown gas.

But although the method of diffusion was capable of deciding the main, or at any rate the first question, it held out no prospect of isolating the new constituent of the atmosphere, and we, therefore, turned our attention in the first instance to the consideration of methods more strictly chemical. And here the question forced itself upon us as to what really was the evidence in favor of the prevalent doctrine that the inert residue from air, after withdrawal of oxygen, water, and carbonic anhydride, is all of one kind.

The identification of "phlogisticated air" with the constituent of nitric acid is due to Cavendish, whose method consisted in operating with electric sparks upon a short column of gas confined with potash over mercury at the upper end of an inverted U tube. †

Attempts to repeat Cavendish's experiments in Cavendish's manner have only increased the admiration with which we regard this wonderful investigation. Working on almost microscopical quantities of material, and by operations extending over days and weeks, he thus established one of the most important facts in chemistry. And what is still more to the purpose, he raises as distinctly as we could do, and to a certain extent resolves, the question above suggested. The passage is so important that it will be desirable to quote it at full length.

"As far as the experiments hitherto published extend, we scarcely know more of the phlogisticated part of our atmosphere than that it is not diminished by lime water, caustic alkalies or nitrous air; that it is unfit to support fire or maintain life in animals; and that its specific gravity is not much less than that of common air; so that though the nitrous acid, by being united to phlogiston, is converted into air possessed of these properties, and consequently, though it was reasonable to suppose that part at least of the phlogisticated air of the atmosphere consists of this acid united to phlogiston, yet it was fairly to be doubted whether the whole is of this kind, or whether

* Abstract of a paper by Lord Rayleigh, Sec. R.S., and Prof. William Ramsay, F.R.S., read before the Royal Society, at a special meeting, on January 31.

† Rayleigh, "On an Anomaly Encountered in Determinations of the Density of Nitrogen Gas."—Roy. Soc. Proc., vol. lv., p. 340, 1894.

* Rayleigh, "On the Densities of the Principal Gases," Roy. Soc. Proc., vol. liii., p. 134, 1893.

* Roy. Soc. Proc., vol. lv., p. 344, 1894.

† "Experiments on Air," Phil. Trans., vol. lxxv., p. 372, 1788.

there are not in reality many different substances compounded together by us under the name of phlogisticated air. I therefore made an experiment to determine whether the whole of a given portion of the phlogisticated air of the atmosphere could be reduced to nitrous acid, or whether there was not a part of a different nature to the rest, which would refuse to undergo that change. The foregoing experiments, indeed, in some measure decided this point, as much the greatest part of the air let up into the tube lost its elasticity; yet as some remained unabsorbed, it did not appear for certain whether that was of the same nature as the rest or not. For this purpose I diminished a similar mixture of dephlogisticated and common air, in the same manner as before, till it was reduced to a small part of its original bulk. I then, in order to decompound as much as I could of the phlogisticated air which remained in the tube, added some dephlogisticated air to it, and continued the spark until no further diminution took place. Having by these means condensed as much as I could of the phlogisticated air, I let up some solution of liver of sulphur to absorb the dephlogisticated air, after which only a small bubble of air remained unabsorbed, which certainly was not more than $\frac{1}{115}$ of the bulk of the phlogisticated air let up into the tube; so that if there is any part of the phlogisticated air of our atmosphere which differs from the rest, and cannot be reduced to nitrous acid, we may safely conclude that it is not more than $\frac{1}{115}$ part of the whole."

Although Cavendish was satisfied with his result, and does not decide whether the small residue was genuine, our experiments about to be related render it not improbable that his residue was really of a different kind from the main bulk of the "phlogisticated air," and contained the gas now called argon.

Cavendish gives data* from which it is possible to determine the rate of absorption of the mixed gases in his experiment. This was about 1 c. c. per hour, of which two-fifths would be nitrogen.

III. METHODS OF CAUSING FREE NITROGEN TO COMBINE.

To eliminate nitrogen from air, in order to ascertain whether any other gas could be detected, involves the use of some absorbent. The elements which have been found to combine directly with nitrogen are boron, silicon, titanium, lithium, strontium, barium, magnesium, aluminum, mercury, and, under the influence of an electric discharge, hydrogen in presence of acid, and oxygen in presence of alkali. Besides these, a mixture of barium carbonate and carbon at a high temperature is known to be effective. Of those tried, magnesium in the form of turnings was found to be the best. When nitrogen is passed over magnesium, heated in a tube of bright glass to bright redness, combustion with incandescence begins at the end of the tube through which the gas is introduced, and proceeds regularly until all the metal has been converted into nitride. Between 7 and 8 liters of nitrogen can be absorbed in a single tube; the nitride formed is a porous, dirty orange-colored substance.

IV. EARLY EXPERIMENTS ON SPARKING NITROGEN WITH OXYGEN IN PRESENCE OF ALKALI.

In our earliest attempts to isolate the suspected gas by the method of Cavendish, we used a Ruhmkorff coil of medium size actuated by a battery of five Grove cells. The gases were contained in a test tube standing over a large quantity of weak alkali, and the current was conveyed in wires insulated by U-shaped glass tubes passing through the liquid round the mouth of the test tube. With the given battery and coil a somewhat short spark or arc of about 5 mm. was found to be more favorable than a longer one. When the mixed gases were in the right proportion, the rate of absorption was about 30 c. c. per hour, or thirty times as fast as Cavendish could work with the electrical machine of his day.

To take an example, one experiment of this kind started with 50 c. c. of air. To this oxygen was gradually added, until oxygen being in excess, there was no perceptible contraction during an hour's sparking. The remaining gas was then transferred at the pneumatic trough to a small measuring vessel, sealed by mercury, in which the volume was found to be 1·0 c. c. On treatment with alkaline pyrogallate, the gas shrank to 0·32 c. c. That this small residue could not be nitrogen was argued from the fact that it had withstood the prolonged action of the spark, although mixed with oxygen in nearly the most favorable proportion.

The residue was then transferred to the test tube with an addition of another 50 c. c. of air, and the whole worked up with oxygen as before. The residue was now 2·2 c. c., and, after removal of oxygen, 0·76 c. c.

Although it seemed almost impossible that these residues could be either nitrogen or hydrogen, some anxiety was not unnatural, seeing that the final sparking took place under somewhat abnormal conditions. The space was very restricted, and the temperature (and with it the proportion of aqueous vapor) was unduly high. But any doubts that were felt upon this score were removed by comparison experiments in which the whole quantity of air operated on was very small. Thus, when a mixture of 5 c. c. of air with 7 c. c. of oxygen was sparked for 1¼ hours, the residue was 0·47 c. c., and after removal of oxygen, 0·06 c. c. Several repetitions having given similar results, it became clear that the final residue did not depend upon anything that might happen when sparks passed through a greatly reduced volume, but was in proportion to the amount of air operated upon.

No satisfactory examination of the residue which refused to be oxidized could be made without the accumulation of a larger quantity. This, however, was difficult of attainment at the time in question. It was thought that the cause probably lay in the solubility of the gas in water, a suspicion since confirmed. At length, however, a sufficiency was collected to allow of sparking in a specially constructed tube, when a comparison with the air spectrum taken under similar conditions proved that, at any rate, the gas was not nitrogen. At first scarcely a trace of the principal nitrogen lines could be seen, but after standing over water for an hour or two these lines became apparent.

* Phil. Trans., vol. lxxviii., p. 271, 1788.

V. EARLY EXPERIMENTS ON WITHDRAWAL OF NITROGEN FROM AIR BY MEANS OF RED HOT MAGNESIUM.

A preliminary experiment carried out by Mr. Percy Williams on the absorption of atmospheric nitrogen, freed from oxygen by means of red hot copper, in which the gas was not passed over, but simply allowed to remain in contact with the metal, gave a residue density of 14·88. This result, although not conclusive, was encouraging; and an attempt was made on a larger scale by passing atmospheric nitrogen backward and forward over red hot magnesium from one large gas holder to another to obtain a considerable quantity of the heavier gas. In the course of ten days about 1,500 c. c. were collected and transferred gradually to a mercury gas holder, from which the gas was passed over soda lime, phosphoric anhydride, magnesium at a red heat, copper oxide, soda lime and phosphoric anhydride into a second mercury gas holder. After some days the gas was reduced in volume to about 200 c. c., and its density was found to be 16·1. After further absorption, in which the volume was still further reduced, the density of the residue was increased to 19·09.

On passing sparks for several hours through a mixture of a small quantity of this gas with oxygen, its volume was still further reduced. Assuming that this reduction was due to the further elimination of nitrogen, the density of the remaining gas was calculated to be 20·0.

The spectrum of the gas of density 19·09, though showing nitrogen bands, showed many other lines which were not recognizable as belonging to any known element.

VI. PROOF OF THE PRESENCE OF ARGON IN AIR BY MEANS OF ATMOLYSIS.

It has already (§ II) been suggested that if "atmospheric nitrogen" contains two gases of different densities, it should be possible to obtain direct evidence of the fact by the method of atmolysis. The present section contains an account of carefully conducted experiments directed to this end.

The atmolyzer was prepared (after Graham) by combining a number of "churchwarden" tobacco pipes. At first twelve pipes were used in three groups, each group including four pipes connected in series. The three groups were then connected in parallel, and placed in a large glass tube closed in such a way that a partial vacuum could be maintained in the space outside the pipes by a water pump. One end of the combination of pipes was open to the atmosphere; the other end was connected to a bottle aspirator, initially full of water, and so arranged as to draw about 2 per cent. of the air which entered the other end of the pipes. The gas collected was thus a very small proportion of that which leaked through the pores of the pipes, and should be relatively rich in the heavier constituents of the atmosphere. The flow of water from the aspirator could not be maintained very constant, but the rate of 2 per cent. was never much exceeded.

The air thus obtained was treated exactly as ordinary air had been treated in determinations of the density of atmospheric nitrogen. Oxygen was removed by red hot copper, followed by cupric oxide, ammonia by sulphuric acid, moisture and carbonic acid by potash and phosphoric anhydride.

In a total weight of approximiately 2·3 grammes the excess of weight of the diffused nitrogen over ordinary atmospheric nitrogen was in four experiments, 0·0049, 0·0014, 0·0027, 0·0015.

The mean excess of the four determinations is 0·00262 gramme, or, if we omit the first, which depended upon a vacuum weighing of two months old, 0·00187 gramme.

The gas from prepared air was thus in every case denser than from unprepared air, and to an extent much beyond the possible errors of experiment. The excess was, however, less than had been expected, and it was thought that the arrangement of the pipes could be improved. The final delivery of gas from each of the groups in parallel being so small in comparison with the whole streams concerned, it seemed possible that each group was not contributing its proper share, and even that there might be a flow in the wrong direction at the delivery end of one or two of them. To meet this objection, the arrangement in parallel had to be abandoned, and for the remaining experiments eight pipes were connected in simple series. The porous surface in operation was thus reduced, but this was partly compensated for by an improved vacuum. Two experiments were made under the new conditions, in which the excess was I, 0·0037; II, 0·0033.

The excess being larger than before is doubtless due to the greater efficiency of the atomlyzing apparatus. It should be mentioned that the above recorded experiments include all that have been tried and the conclusion seems inevitable that "atmospheric nitrogen" is a mixture, and not a simple body.

It was hoped that the concentration of the heavier constituent would be sufficient to facilitate its preparation in a pure state by the use of prepared air in substitution for ordinary air in the oxygen apparatus. The advance of 3½ milligrammes on the 11 milligrammes by which atmospheric nitrogen is heavier than chemical nitrogen is indeed not to be despised, and the use of prepared air would be convenient if the diffusion apparatus could be set up on a large scale and made thoroughly self-acting.

VII. NEGATIVE EXPERIMENTS TO PROVE THAT ARGON IS NOT DERIVED FROM NITROGEN FROM CHEMICAL SOURCES.

Although the evidence of the existence of argon in the atmosphere, derived from the comparison of densities of atmospheric and chemical nitrogen and from the diffusion experiments (§ VI), appeared overwhelming, we have thought it undesirable to shrink from any labor that would tend to complete the verification. With this object in view, an experiment was undertaken and carried to a conclusion on November 13, in which three liters of chemical nitrogen, prepared from ammonium nitrite, were treated with oxygen in precisely the manner in which atmospheric nitrogen had been found to yield a residue of argon. The gas remaining at the close of the large scale operations was worked up as usual with battery and coil until the spectrum showed only slight traces of the nitrogen lines. When cold, the residue measured 4 c. c. This was transferred, and after treatment with alkaline pyrogallate to remove oxygen, measured 3·3 c. c. If atmospheric nitrogen had been employed, the final residue should have been about 30 c. c. Of the 3·3 c. c. actually left, a part is accounted for by an accident, and the result of the experiment is to show that argon is not formed by sparking a mixture of oxygen and chemical nitrogen.

In a second experiment of the same kind 5,660 c. c. of nitrogen from ammonium nitrite was treated with oxygen. The final residue was 3·5 c. c., and was found to consist mainly of argon.

The source of the residual argon is to be sought in the water used for the manipulation of the large quantities of gas (6 liters of nitrogen and 11 liters of oxygen) employed. When carbonic acid was collected in a similar manner and subsequently absorbed by potash, it was found to have acquired a contamination consistent with this explanation.

Negative experiments were also carried out, absorbing nitrogen by means of magnesium. In one instance 3 liters of nitrogen prepared from ammonium chloride and bleaching powder was reduced in volume to 4·5 c. c., and on sparking with oxygen its volume was further reduced to about 3 c. c. The residue appeared to consist of argon. Another experiment, in which 15 liters of nitrogen from ammonium nitrite was absorbed, gave a final residue of 3·5 c. c. Atmospheric nitrogen, in the latter case, would have yielded 150 c. c., hence less than $\frac{1}{15}$ of the normal quantity was obtained. It should be mentioned that leakage occurred at one stage, by which perhaps 200 c. c. of air entered the apparatus, and besides, the nitrogen was collected over water from which it doubtless acquired some argon.

Quantitative negative experiments of this nature are exceedingly difficult and require a long time to carry them to a successful conclusion.

(To be continued.)

THE MICROSCOPIC ANALYSIS OF STEELS.

AT a recent meeting of the Societe d'Encouragement, in Paris, M. Osmond, the well-known metallurgist, brought to the notice of members the results of his recent experiments in the field of metallography, and presented a method, capable of being practically adopted in works, of making a microscopic analysis of steel. The method comprises, independent of the preparatory polishing, three operations: (1) a polishing in bass relief on parchment, with a small quantity of brown, rouge and water; (2) polishing, on parchment, with precipitated calcium sulphate and an infusion of liquorice root; (3) an application of tincture of iodine or nitric acid.

These three operations permit of five constituents being traced in steel, of which two are known and have been well defined, a third known, but not well defined, while the other two have hitherto remained unknown. These five constituents are: (1) "Ferrite," or the iron itself, fairly pure; (2) "cementite," or carburet of iron conforming to the formula Fe_3C; (3) "sorbite," which accompanies the cementite, and where the carbon appears to be in the state of carbon due to hardening; (4) "martensite," the principal constituent of hardened steels, consisting of small crystals of iron containing the carbon due to hardening in solution; (5) "troostite," which comes next to martensite in hardened steels. These five constituents, between which certain transition forms are found, join together in multiple combinations in building up the complex structure of steels. Experiments made by M. Osmond, with four different steels, each having a larger percentage of carbon than the other, show how these combinations vary: (1) With the degree of heat; (2) with the degree of heat in hardening; (3) with the rapidity of the cooling. From the experiments made, the inference is drawn that the different conditions of thermic treatment of the steels leave behind in the structure of the cooled metal characteristic indications of sufficient precision to enable the manufacture to be accurately carried on to the desired specification. M. Osmond supported his conclusions by a number of enlarged micro-photographic slides projected on the screen, showing the appearance of the different steels in their different conditions.

A NEW TREATMENT FOR CHRONIC JOINT AFFECTIONS.

A SOMEWHAT novel method of treating chronic rheumatic and gouty affections has been tried at St. Bartholomew's Hospital and at the Northwest Hospital, in London. As described by Mr. Alfred Willett, the Tallerman-Sheffield local dry hot air bath is an invention by which dry air at temperatures from 250° to 300° F. is applied to a portion of the body, such as hand or foot, knee or elbow, an arm or leg. The bath itself consists of a copper cylinder, varying in size and shape according to the part to be inclosed. At one end the limb enters, surrounded by rubber sheeting, and the other is closed by a movable cap working on a pivot, by the use of which, and outlets at the top and bottom of the cylinder, it is found possible to keep the air in the chamber practically dry throughout the operation, notwithstanding the moisture thrown off by the limb inclosed, and instant relief can be afforded the patient if the temperature causes any discomfort. The cylinder is heated by gas burners placed underneath. Precautions are taken to prevent the skin from coming into contact with the heated metal. Mr. Willett's conclusions are decidedly in favor of the treatment in certain cases, and his results may be summarized as follows: The first effect of the heat is to induce a copious diaphoresis; and the circulation of the blood in the part is enormously increased, as is well shown by the bright redness of the limb when removed from the bath. The anodyne effect is often remarkable; pain is generally not only relieved, but entirely removed, so that the patient expresses the great relief he feels and moves the limb with much greater freedom and with much less pain. The cases that appear most likely to be relieved by the treatment are sprains, stiff joints (where there are no very strong adhesions), flatfoot, gonorrhœal rheumatism, acute and chronic gout, chronic ulcers and rheumatism. It deserves also to be employed for its anodyne effect, after forcibly breaking down under an anæsthetic adhesions which have formed in or around a joint; if the limb be placed in

the cylinder, the pain, which is generally severe, is greatly lessened, and the secondary stiffness is much diminished. Mr. Willett was of opinion that but little assistance would be afforded by this bath in overcoming firm, fibrous, articular adhesions. Sooner or later the adhesions will have to be forcibly broken down under an anæsthetic.

The treatment was applied at the Northwest London Hospital by Mr. Mayo Collier upon eight cases. The patients suffered from sprains, rheumatoid arthritis, gout, chronic leg ulcer and tuberculous knee joint. Improvement was reported in all cases, and in some it was quite striking.—Medical Record.

[FROM BULLETIN 78, CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION.]

A PREVENTIVE FOR THE CABBAGE ROOT MAGGOT.

By MARK VERNON SLINGERLAND.

THIS idea of preventing the attacks of the cabbage root maggot by closely encircling the stems of the plants by paper collars resting upon the ground first originated in Michigan, in 1887. Professor Tracy, of Detroit, experimented with heavy manila paper, but not with satisfactory results. Professor Cook also experimented with the paper cards, and although he secured hundreds of eggs where he used adhesive fly paper for the cards, yet he could not recommend the method; he seems not to have tested it again.

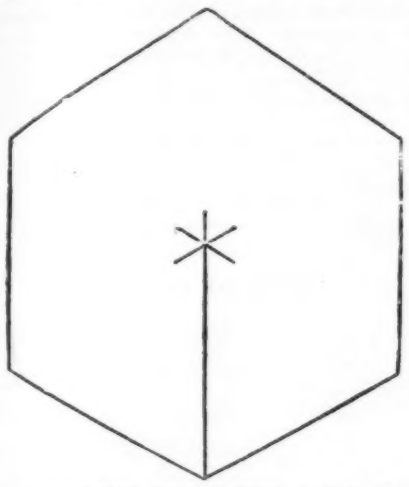


FIG. 1.—OUTLINE OF TARRED PAPER CARD.
(Natural size.)

In the spring of 1889, the idea occurred to Mr. Goff to substitute for the manila paper cards made of tarred paper, and further protection was secured by the use of a bit of grafting wax to form a more perfect union between the paper and the stem. His experiment was a complete success.

This preliminary experiment was so successful that the next season Mr. Goff perfected the method by devising a very simple tool which would cut, at a single operation, a six-sided card with a slit reaching to the center, and with a star-shaped cut at the center, so that the same card may accommodate itself to any sized stem and still make a tight joint. He had these cards tested by several large cabbage growers that season. Mr. J. M. Smith, of Green Bay, Wis., reported that he had about 7,000 plants protected with the cards and secured a splendid crop; while a like number of unprotected plants near by would have been an entire failure if he had not resorted to the hand-picking of the maggots. Messrs. Smith Brothers, of the same place, also reported a like success from the use of the cards. In 1891 these same parties again used the cards. The former reported that he lost from the maggots not more than 25 plants of the 10 000 to 15,000 that he protected with the cards; ordinarily he would have lost from three-quarters to nine-tenths of the crop. Messrs. Smith Brothers used about 15,000 of the cards and had no maggots, except where the cards were not properly put on.

These experiments having established the practicability of the tarred paper cards, the method was published by Mr. Goff in 1891. We have reproduced Mr. Goff's outline drawings of one of the cards (Fig. 1) natural size, of the cutting tool (Fig. 3) about ½ natural size, and of the diagram showing how the tool is to be used (Fig. 2), much reduced. We quote Mr. Goff's concise descriptions of the cards and tool, and their use: "The cards are cut in a hexagonal form, in order to better economize the material, and a thinner grade of tarred paper than the ordinary roofing felt is used, as it is not only cheaper, but beng more flexible, the cards made from it are more readily placed about the plant without being torn.

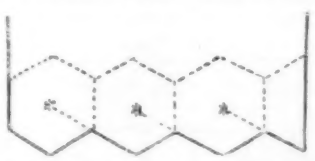


FIG. 2.—DIAGRAM SHOWING HOW THE TOOL IS USED.
The dotted line indicates the position of the edge of the tool.

"The blade of the tool, which should be made by an expert blacksmith, is formed from a band of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center, as shown in Fig. 3. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut, the edge may be ground on a grindstone. It is important that the angles in the blade be made perfect and that its outline represents an exact half hexagon.

"To use the tool, place the tarred paper on the end of a section of a log or piece of timber and first cut the lower edge into notches, as indicated in Fig. 2, using only one angle of the tool. Then commence at the left side and place the blade as indicated by the dotted lines, and strike at the end of the handle with a light mallet, and a complete card is made. Continue in this manner across the paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made and properly used.

"The cards should be placed about the plants at the time of transplanting. To place the card bend it slightly, to open the slit, then slip it on to the center, the stem entering the slit, after which spread the card out flat, and press the points formed by the star-shaped cut snugly around the stem." At a, in Fig. 4, is shown a card properly applied to the stem of a geranium; b shows a card carelessly put on.

Mr. Smith writes us: "If the soil is very light and loose, care must be taken that the plants are not pressed down too deeply so as to form a cup or dish around the plant. . . . If the land is very soft, the better plan would be to roll it before setting the plants." To further impress the idea of properly putting on the cards, we have introduced Fig. 4, which shows a card properly applied at a; and one carelessly put on at b, under which a female fly could easily crawl and lay her quota of eggs near the stem. With a little practice, the card can be applied properly just as easily and as quickly as it can be done carelessly. Growers will soon learn that the cards, to be effective, must be properly applied; and that when the cards are thus applied, they are very effective.

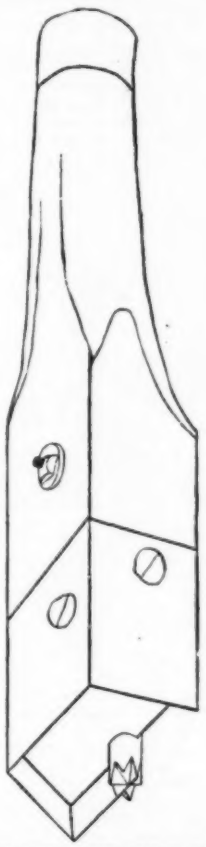


FIG. 3.—TOOL FOR CUTTING THE CARDS.
(About ½ natural size.)

Our experience satisfies us that these cards will afford almost complete protection to cabbages and cauliflowers from the cabbage root maggot, if a little care is taken in applying them. The protection evidently comes, not from the smell of the cards tending to drive away the fly, but from her inability to get to the stem to lay her eggs. The experience of the Messrs. Smith at Green Bay shows that the cards are practicable on a large scale. Messrs. Smith Brothers wrote us they cut 20,000 for use this year; it costs them for material and labor about $1 to protect 1,000 plants. No second treatment is required; sometimes a little care is necessary in hoeing, so as not to cover the cards with dirt. In our State it will not be necessary to use the cards after May 20. They will not last more than one season, but new ones can be made during the winter when other work is not so pressing. Most of the Long Island gardeners with whom we discussed the method were favorably impressed with it, but some of them set their plants so deeply that it would not be practicable to properly put on the cards. The plants are set so deeply that the bases of the first two or three leaves are below the surface. Of this method of setting, Prof. Bailey says (Bull. 37, p. 405, of the Cornell Agr. Expt. Station): "We find as a result of three years' investigation that the depth at which strong and stocky cabbage plants are set does not influence the extent or weight of the crop."

Therefore, we believe that gardeners will find that this method, which is unfortunately only applicable to cabbages and cauliflowers, will prove, when properly carried out, the cheapest, most practicable, and most efficient method yet devised for preventing the ravages of the cabbage root maggot. However, the same objection may be raised against it as would apply to any preventive method; that is, it must be kept up for several years, as the experience of Messrs. Smith Brothers shows. Our discovery that the pest breeds freely on several common weeds offers a reasonable explanation why this is true. If all of the cruciferous weeds in the neighborhood could be exterminated and none of its other cultivated food plants be grown unprotected near by, then a few years of prevention with the cards would doubtless starve out the pest in that locality.

Habits of the First Brood of Maggots.—In emerging, the maggot pushes through the blunter end of the egg, which splits down along the sides of the deep groove. The young maggots at once attack the surface of the root. By means of its strong, curved, hook-like mouth parts, it soon rasps out a burrow along the surface. The tender rootlets seem to be the first objective point of the young larvæ. These destroyed, the maggots turn their attention to the main root, into which they burrow, often girdling it as shown in Fig. 5. The figure shows the maggots at this work, and their effect on a cabbage root.

Usually the maggots are found in slimy burrows in the bark just beneath the surface; and sometimes one is found just entering the bark, "with the end of its body projecting stiffly out, like a peg driven in half its length," as Dr. Fitch describes it. The interior portion of a rather large cabbage root is so woody that the maggots do not often work in it, but they sometimes penetrate into the interior of the softer stem farther up. When but a few maggots occur on a root, they are usually to be found in their burrows; but often so many maggots attack one plant that as they increase in size there is not room for all in the bark. In this case, as Mr. Fletcher says, "most of them lie outside in the soil, which is kept wet by the juices of the injured plant." Where we have seen this state of affairs, the maggots were nearly full grown and the plant had toppled over. Thus, all the maggots doubtless had access to the plant for food during much of their life, but probably they were being nourished by the juices exuding from the injured plant when found. When this stage in the ravages of the maggots is reached, on a cabbage plant especially, the slimy mass of soil and the then rotting roots combine to give out one of the most sickening odors imaginable.

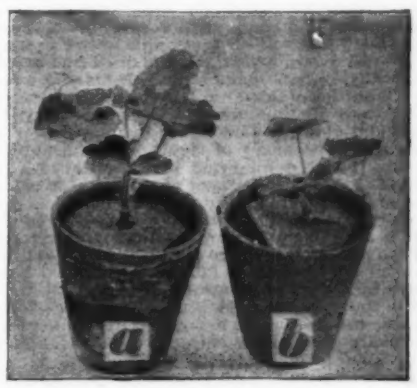


FIG. 4.
a, tarred paper card properly put on; b, a card carelessly applied that will not prevent.

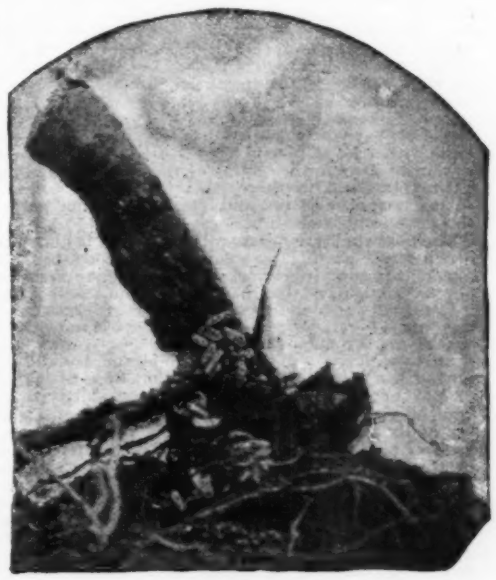


FIG. 5.—CABBAGE ROOT MAGGOTS.

The maggots work in a similar manner on radishes and turnips, except that often their slimy burrows extend irregularly about in the interior of the succulent root. Gardeners attribute much of the toughness and stringiness of turnips and radishes to the work of these maggots.

In 1878 Dr. Riley found the maggots not "only working in the normal way on the roots, but also burrowing in the stout mid-ribs of the leaves." Mr. Fletcher noticed a few of the maggots working in a similar manner at Ottawa in 1890.

THE REGISTERED MAIL.

THE banks transmit millions of dollars in bonds by registered mail every month, and the express companies millions in currency. The other day a package of money was broken open in transit from San Francisco to New York. When it arrived here, its contents were counted by an agent of the express company to which it was sent. Not a dollar was missing, although the package contained $200,000 in greenbacks. There were nine other packages for the same company in this mail, the entire remittance amounting to $1,000,000. Large quantities of gold and silver are also transported, principally for the government for the liquidation of money order obligations and in payment for stamps. All the money for these purposes goes through the registry division. There is seldom less than $250,000 of silver and gold in the safe at the New York Post Office, though this money is delivered as quickly as possible. A Sun reporter counted at one time 120 packages of $20 gold pieces, the aggregate amount of which was $120,000, and 15 bags of silver, containing in all about $20,000. Returning in two hours, he found that this treasure had all been delivered or sent on its journey, and another mail had brought in about $400,000 in gold and $20,000 in silver. By this same mail came 8 packages of bonds, each weighing 12 pounds, the total value of which was estimated to be about $2,000,000.

But money and bonds are not the only contents of registered packages. For example, every transatlantic steamer brings several bags of dried rind of bacon, with which Italians make soups. Italians also receive large quantities of dried mushrooms by registered mail. Then there are innumerable packages of patterns, shoes, and gloves. The shoes and gloves are sometimes sent in packages of rights or lefts, ostensibly as samples, the mates following in other packages. This method of avoiding payment of duties is occasionally successfully operated. But the customs officers are on the alert, and tricks of this kind must be well played to succeed. There are two customs officers on duty daily to pass upon foreign mails. Packages adjudged doubtful are stamped as follows: "Supposed liable to United States customs duties." Then the postal officials notify the persons to whom the packages are addressed, and the owners must open the packages in the presence of the customs officers, who make appraisals if dutiable articles are found. Sometimes very innocent looking packages are suspected. For instance, an old book was marked doubtful the other day on the theory that it might contain something of greater intrinsic value than the musty leaves of an old volume of Shakespeare.

In the New York Post Office, when a letter is presented for registration, it is inspected by the receiving clerk to ascertain whether it is in good condition, firmly sealed, properly addressed, and sufficiently prepaid, and that the name and address of the sender have been indorsed on it. These requirements being met, the clerk records the letter in a book composed of alternate thin and thick leaves, a manifold copy of the entry being obtained by means of a sheet of carbon paper placed between the two. The thin sheets are perforated in oblong sections for ready separation, and constitute the receipts issued to the public. Each receipt bears a distinct number in a series running from 1 to 100,000, and every letter registered has the number of the receipt issued for it indorsed on its face. The condition of the letter envelope is now inspected by another clerk, and, if perfect, the imprint of a hand stamp is impressed across the edge of the flap to betray any tampering.

These preliminaries being completed, a card known as the return receipt is prepared and attached to the letter by means of a rubber band. On one side of the card appear the number, date of mailing, name of addressee, and destination of the letter; on the other, the name and full address of the sender, to whom the receipted card will be returned when the letter has been delivered. In its numerical order the letter passes to a separating clerk, and with ninety-nine others, composing an even hundred, is distributed to one of the six cases, where it will be further treated. The separating clerk verifies the count of each hundred letters before separating another hundred, and as frequently as may be necessary delivers each subdivision to the clerks in charge of the cases. A case consists of a long table with a set of pigeon holes bearing the names of the larger cities in the section of the country assigned to that case, and in these pigeon holes the clerk in charge boxes the letters, and from time to time parcels them out to his assistants.

The next step is the preparation of what is known as a registered package envelope. This consists of an ingeniously contrived envelope specially manufactured out of particularly tough paper for the use to which it is put, and also numbered in a series of 100,000. On the face of each envelope appears its number and spaces for the name of the post office, county, and State to which it will be sent, while the back is arranged for notations of its condition by every postal official through whose hands it subsequently passes. One of these envelopes having been addressed, entry of the letter to be inclosed in it is made on a registry bill, which shows the date of mailing, name of the post office using it, name of the post office to which it will be sent, number of the registered package envelope, and, finally, the registered number of the letter to be placed in it, and the name of its addressee. The bill and the letter are placed in this envelope, which then passes to a clerk who removes its contents, compares the letter with the entry on the bill, and calls the registered letter and registered package envelope numbers, together with their destination, to an assistant who records these particulars in the mailing book. The letter and bill are now replaced in the envelope and passed to another clerk for final verification of contents and sealing. The sealing consists in an application of blue mucilage to the three flaps of the envelope, which when once closed cannot be reopened without mutilations, the blue mucilage exposing any attempt to open the envelope by any steaming process. The postmark showing the mailing office and date is now affixed, and the envelope, with a lot of others from the same case, goes to the pouch room, where another separation is necessary in order that it may get to the registered pouch that will carry it to the distributing office nearest its final destination. The contents of the registered package envelope can now only be ascertained by reference to the registered letter numbers charged against the envelope number in the mailing book, or the more full description of the letters on the registry bill, which is under seal, and therefore inaccessible. The registered package envelope is entered by origin, number, and destination on the book of the pouch in which it is to be dispatched; a carbon manifold record of the packages is inclosed in each pouch being preserved, the duplicate sheet of each pouch forming the bill of advice to the office to which the pouch is sent.

When as many packages as the pouch will hold have been entered on the proper book, two clerks verify the entries, sign the last sheet of the bill, place it with the packages in the pouch, adjust the strap that secures it, and finally attach that mechanical wonder called a rotary lock. This lock has a fixed serial number engraved on its side, which serves to identify it, and a rotary number, which unerringly advances one every time the lock is opened. The pouch is then delivered to a railway postal clerk, who receipts for it by lock and rotary numbers, and it remains under constant guard until its destination is reached. Keys that open the rotary locks are issued only to post offices exchanging registered pouches, and a careful comparison of the rotary number of the lock with its entry on the pouch bill is the first duty of the clerks opening a registered pouch. Any discrepancy between the rotary number advised on the bill and that shown by the lock received would indicate an irregularity to be at once investigated. At every transfer from one clerk to another of a registered letter, registered package envelope, or registered pouch, a receipt is taken, and by these means no difficulty is experienced in tracing a letter from the time it is first mailed until delivered to its addressee. These rotary locks cost $15 each, and when the number 999 is turned they must be returned to the makers for readjustment.—N. Y. Sun.

WHALING IN 1845.

IN 1845 the bark Sarah, of New Bedford, was cruising off the river La Platte for sperm whales. She carried three boats at the davits and a crew of twenty-two men, which, with six men to each boat, left four men to keep ship when the boats were off for whales. One morning about nine o'clock the man at the main-topgallant crosstrees sang out, "There she blows!" and repeating it at regular intervals, which indicated unmistakably that sperm whales were in sight.

As the man continued to sing out, the captain hailed with the question, "Where away?" "Two points forward of the lee beam, sir." "Keep him off two points, brace in the yards, get lines in the boats, keep a sharp lookout there aloft." While the ship was heading for the whale all was bustle and excitement on deck.

The boats were hoisted and the cranes swung from underneath, and then the boats were lowered level with the rail and each boat's crew stood by for the order to "lower away." When within about three-quarters of a mile from the whale the ship was luffed up into the wind, the maintopsail hauled aback and the order came "lower away."

As the boats struck the water the crews tumbled over the side, each man quickly taking his place and with oars all ready the boats were shoved off and the race began, each boat's crew doing its best to reach the whale first. I belonged to the captain's boat and pulled the tub oar. We had pulled but a short distance when the whale went down. We had got his bearings, for a whale undisturbed will always go in a straight line, so after pulling nearly to where he disappeared, we peaked our oars and waited for him to come up.

In a short time he broke water and not far from our boat. How quickly we got down to our oars and how our boat rushed through the water, as every man threw his whole strength on the long sixteen feet sweeps, every moment bringing us nearer the whale. The captain, with steering oar in one hand and heaving on the after oar with the other, kept urging us to greater effort. "Spring, I tell you, spring!" "Bend your backs and break your oars; pull boys, do pull!" I could always tell by looking in the captain's face when we were near a whale, for he would turn very white around the mouth. As I looked up at him I saw the never-failing sign, and the next moment he shouted to the boat steerer. "Stand up, Ned." Ned peaked his oar and was on his feet in an instant with harpoon poised and ready for the word. "Give it to him!" sang out the captain, and the next moment the harpoon was buried deep in the monster's side.

With one of his mighty flukes the whale sounded rapidly, taking out nearly a hundred and fifty fathoms of line. We had backed the boat away, and were now nipping the two parts of the line together with canvas holders so as to impede his downward progress and tire him before he took all of our line. At last the line began to slacken, and then it was, "haul in" and stow away in the stern sheets ready to run out again should the whale go down. At last he came to the surface, seemingly paralyzed or tired. The mate's boat was near, and pulling up, he sent a well directed lance under the fin and the whale went down again.

Then said the captain, when he saw what the mate had done, "He'll be dead enough to skin when he comes up," and, though not exactly dead when he again appeared, he needed no more lancing. He could just clear the thick blood from his spout hole, and soon went in his flurry. Taking a large circle and going around with the sun, with head well out of water, with blood and foam all about him, he soon turned on his side and lay very still. He was dead, and then with three boats stretched out on a tow line he was taken alongside the ship and made fast with the fluke chain.

We had been gone from the ship not over an hour, and now commenced preparations for "cutting him in." Immense tackles were got up under the maintop, with falls leading forward to the windlass, and then began the hardest part of a whaleman's work, heaving in the blubber. First the head is cut off and turned on end, the oil is taken from that, and next comes the stripping of the blubber from the carcass. The blubber is lowered into the blubber room in long strips called blanket pieces. Then it is cut up by the blubber room men in pieces of proper size for the mincer, and from the mincer it goes into the try kettle, where the oil is extracted from it, leaving the scraps to be used as fuel. The oil is then dipped from the try kettle into a "cooler," and from the cooler into casks for "stowing down." This particular whale "stowed down" one hundred barrels of clear sperm oil.—Charles F. Walker, in The Torch.

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